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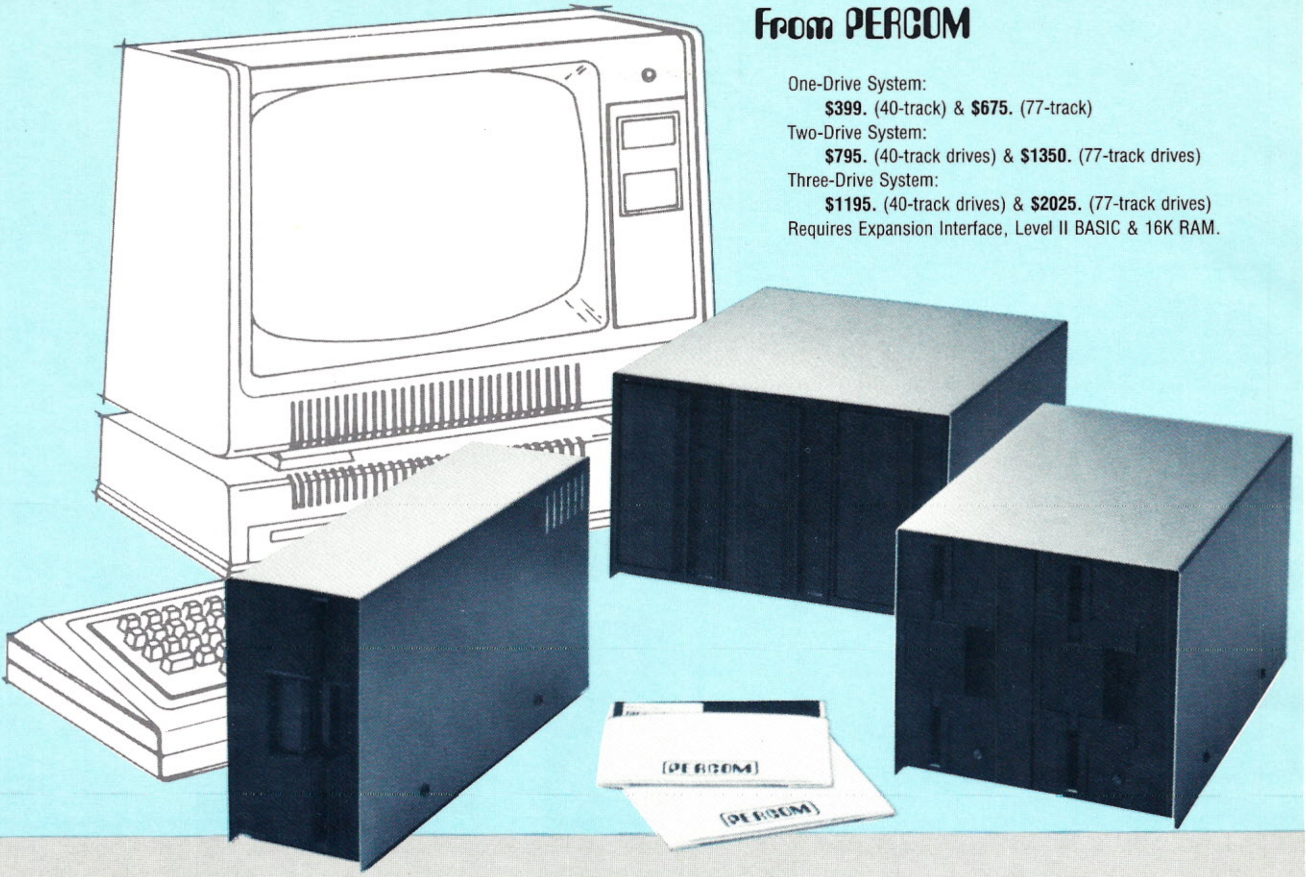

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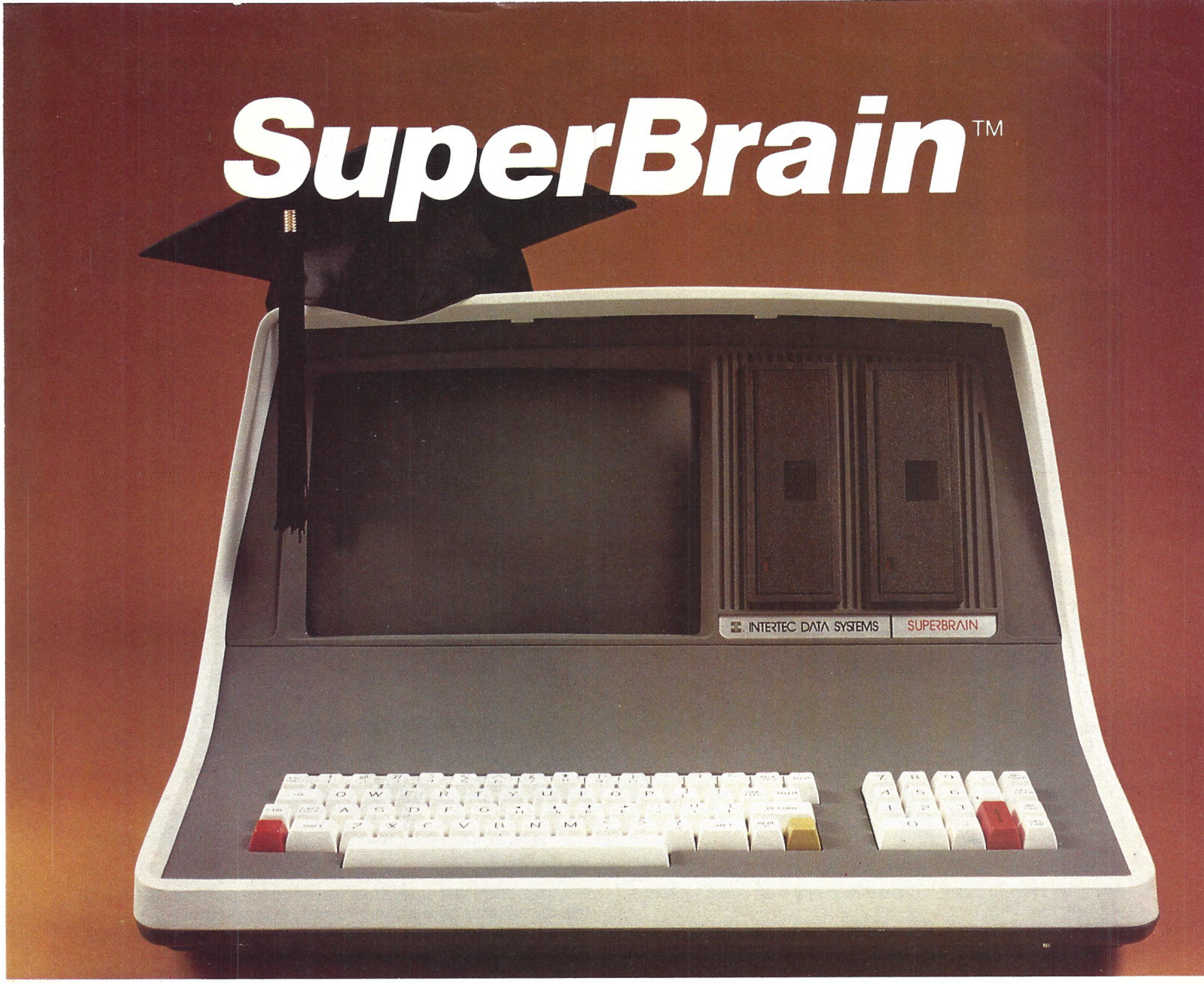

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contents: dec. '79

ARTICLES

DEPARTMENTS

Cover: The Ithaca Intersystems DPS-1, a Z-80-based microcomputer system offering 8- and 16-bit compatibility in an IEEE S-100 standard mainframe. 20-card capacity and built-in breakpoints offer a tool for testing software and hardware—directly accessible from the front panel designed for fast, instinctive operation.

micro info

$ This symbol next to a title in the table of contents indicates that the article is a business-application article.

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PUBLISHER'S REMARKS

Wayne Green

Midwest Scientific Instruments

Much of Instant Software's bookkeeping is now being put on their new Midwest Scientific Instruments system.

It was silly for a computer program business to do all its bookkeeping by hand, so we looked around to see what system might be able to handle the volume of business expected for Instant Software. The only one we were able to find that seemed ready to use was the MSI.

The demonstration of the system at the yearly dealer meeting in Vail last spring showed what it could do, and it was impressive. The operating system is probably the most advanced in the microcomputing field. After seeing the demonstration, we made arrangements for getting a system for inhouse use by Instant Software.

Curt Childress, the president of MSI, personally flew in the equipment and set it up for operation.

The MSI has a 10 M bytes hard disk plus dual floppies and comes armed with extensive software that has been thoroughly tested and debugged. ISI is starting with the accounts receivable, daily orders and inventory programs. This is expected to be expanded to include general ledger and accounts payable.

In addition to setting the system up, we also had an opportunity to talk at length with Curt, an interesting chap. Now, if only he would start moving MSI to New Hampshire. . . .

IBM Reads Kilobaud Microcomputing

The microcomputer from IBM, scheduled for introduction in December this year, sounds good. The lower-price systems will cost about $4000 and use a simple keyboard with a plasma display . . . going later to an LCD display (as I have suggested in my editorials). This will allow IBM to put more of their money into chips and memory instead of into a TV-type display unit.

The IBM strategy apparently includes their own retail stores in over 200 U.S. cities and basic computer systems selling for under $1000 by 1981. IBM is also entering the video disk business, so we should see some use of this technology for computers.

Radio Shack may have one hell of a battle on its hands in the next year or two. IBM can, when it wants to, react quickly to needed changes. It has its own facilities for making chips, so it can outflank firms that depend on outside suppliers. Radio Shack has already discovered that they should have taken over a disk firm; disk back orders are now as long as six months.

I notice that Xerox is entering the field—and going about it the right way, for example, buying a disk firm, a printer. When I was consulted by a large firm interested in the microcomputing market, I advised this approach as the only one that would give them growth control. The more you control, the safer you are, and the lower are your eventual costs.

Club Opportunity

Most of the microcomputer clubs were formed around a hard core of computer hobbyists, and the tendency has been to cater to this elite group. If they will open up a bit, clubs may find growth and an eager group of newcomers whom they will be able to help immeasurably.

Tens of thousands of microcomputer buyers have created a necessity for fundamental education so these people will be able to get more from their systems. We know they are interested—after all, they shelled out an average of $1000 each to get involved. Now they want to learn, but find it difficult to make the trip entirely via the magazines and books available.

I suggest that clubs have beginners classes to motivate these people and answer their questions. Classes would serve two purposes: to help clubs grow and to help bring education to a lot of people. I think classes would be a valuable service to the community as well as to the clubs.

How do you get customers for the classes? Simple—put up some posters in computer stores and Radio Shack associate or franchise stores . . . the regular Radio Shacks are not yet permitted to do this. You could send a letter with signatures of your entire club to the president of Radio Shack, Lou Kornfeld, at One Tandy Center, Ft. Worth TX 76102, and ask him to permit stores to have such a poster. Radio Shack has everything to gain and little to lose.

If you could get radio and newspaper coverage of the classes, that would help; and I'd be surprised if *Kilobaud Microcomputing* and *80 Microcomputing* wouldn't list your classes.

Once you are started, please be sure to take some pictures that we can run in the magazines.

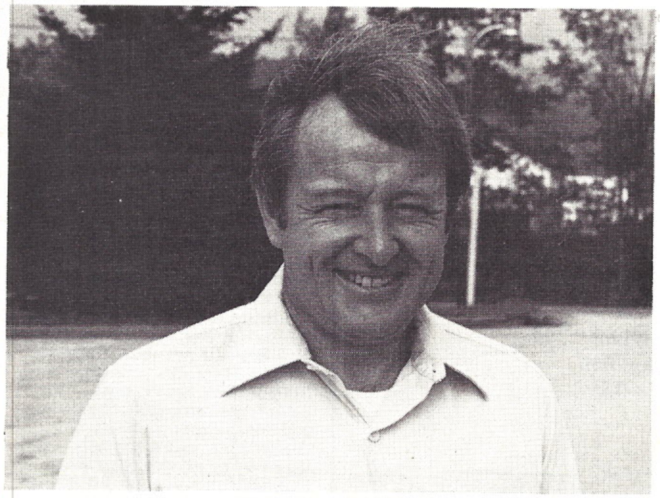
One more thing: charge for the classes. You'll find that this will help most members overcome any conflict of interest that might keep them away from one of the classes. If they have some bucks involved they will hang in there.

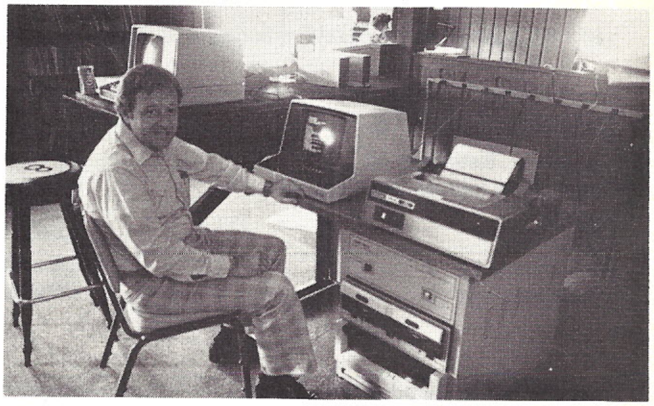
Club Membership

Probably the largest computer club in the country today is the Amateur Computer Group of New Jersey, with 1000 members, which puts on the Trenton Computerfest each year.

A recent ACGNJ newsletter contained the following statistics. Twenty-four percent of the members have more than one computer, for a total of 1140 computers. Of the members who were polled by the club, 388 (34 percent) used the Z-80 chip, 279 (24 percent) used the 8080, 233 (20 percent) used the 6502, and 124 (11 percent) used the 6800.

The most popular system was the TRS-80, with 156 (14 percent), followed by the Imsai, with 131 (11 percent), and TDL/Xitan 79 (7 percent). The SWTP came in with 69 (6 percent), the Apple with 50 (4 percent) and the PET with 56 (5 percent). The poll showed only eight North Stars, 14 Sorcerers and 18 Heaths.





MSI's Curt Childress arrives in Peterborough . . . and sets up a system for Instant Software.

OUTPUT FROM ISI

Sherry Smythe

10,000 Programs?

When I mentioned to someone the other day that Instant Software intended to support a library of over 10,000 programs, he snickered. How many computer programs do you think it will take to teach every subject presently covered in elementary school, high school and college . . . and how many to provide specialized programs for every type of business?

A quick look at the range of business subjects that can be covered may give you a hint as to what is coming. Computers will help make more sales, save time and money, provide happier customers, use fewer people and provide faster information. We will be handling many of these business applications: inventory, accounting, word processing, electronic mail, mailing lists, customer data, index to business data, salesman's data base, sales curves, modeling, temperature control, production line control, security, message center, electronic bulletin board, financial computations, customer polls, advice on shipping delays, order handling, payroll, warranty service, data base of suppliers, executive calendar, phone number monitor, training new employees, ad response vs sales calculations . . . you see what I mean? It's predicted that most uses for microcomputers haven't even been thought of yet.

We at Instant Software look at this as a long-term serious business, even though we are having a ball at it. A few dozen games and a handful of business-oriented programs is just scratching the surface. Programmers will realize that the needed programs must be written and that the sales eventually will be in the millions.

During the past year, Instant Software has been setting up the mechanism for evaluating, publishing and marketing programs for microcomputers. Without this support, the sale of microcomputers could hardly continue to grow. Certainly, the need for systems far outclasses the supply of custom programmers, even if businesses were able to pay the freight. But imagine what it would cost to turn out custom programming for several dozen applications for each system sold?

If you think, as we do, that the uses for microcomputers can do nothing but grow—into an endless number of applications—then why not capitalize on this belief and aim toward taking advantage of this special information? You can do this by knowing how to write the thousands of programs needed and in developing a place for yourself in the chain that brings these programs to the users. Somewhere along the line there are opportunities for thousands of people who recognize what is coming to start on the ground floor and make productive and fun careers.

With Atari becoming more serious, TI finally breaking loose and even IBM getting ready to lumber into the field, the number of good programs that will be required is mind boggling. Microcomputer sales for 1980 are projected to run to at least 600,000 systems; that's more than the total number in existence today. That's about 50,000 per month, and the dollar volume for programs is expected to equal or exceed the hardware volume! A lot of people are going to do very well; are you one of them?

Instant Software needs people with microcomputer hardware or programming experience, marketing people, sales reps . . . it's an endless list.

BOOK REVIEWS

How to Build Your Own Working 16-Bit Microcomputer
Ken Tracton
TAB Books
Blue Ridge Summit PA
1979, Softcover, 95 pp., $3.95

If you have conquered the world of 8-bit computers or feel your byte-size processor is slightly asthmatic for your growing software projects, perhaps you should consider building a system around a 16-bit microprocessor. A recent *Microcomputing* article ("Super Starter Kit" by Richard Mataka, July 1979) detailed the assembly and capabilities of the Technico Super Starter Kit, and Marinchip Systems has an S-100 compatible system on the market.

So far, however, most emphasis has been on the Texas Instruments (TI) 9900 CPU chip. This book continues that emphasis, starting from the ground up. If you want a book that will give cookbook instructions on wiring and circuit layout, this is not the one. Tracton's book describes interfaces and peripheral integration in sufficient detail that an experienced hobbyist or engineer can produce a final product. Certain tricks and innovations are discussed, and circuits for various applications are shown, but the intent is not for a set of construction plans.

The book starts by describing the development of microprocessors, leading up to reasons for selection of the 9900. This approach is beneficial since the user is building from the chip up and all things, such as support and hardware/software availability must be considered.

Tracton describes the architecture and instruction set of the 9900 in concise detail and provides the necessary timing and voltage information. The description of communications-register units as used for serial I/O capability is good. Procedures for obtaining bank select memory and panel lights are shown with appropriate, concise circuits and diagrams. Quirks in the hardware are not neglected; pins with special characteristics are also covered.

Progressively, the CPU and support chips for the system are detailed. The chips described for major functions are all TI products. The 9900 is the CPU, the 9901 provides interrupts and

timers, the 9902 provides for peripheral interface, the 9903 handles synchronous I/O and the 9904 is the clock generator.

The support chips, such as the 9901, to expand the capabilities of the 9900 add some extra class to the system. Since these chips are also made by TI, they work well together in an integrated unit. The 9901 functions as buffer, clock and interrupt interface. Pin-outs and circuits for this chip are described coherently. The 9902, used for asynchronous I/O, is probably the second most important of the set. Circuits for interfacing it to the 9900 and for converting TTL to RS-232 are covered.

The 9903 is only briefly discussed since the average hobbyist probably won't use it. The 9904 is used for a clock generator and may be replaced by a functional equivalent.

After integration of these few circuits, you may have a working system, but what about capabilities? Improvements can be made in memory. What about using different memories? These possibilities are valid and may be extended to cover both ROM and RAM. Memory-mapped I/O can be added, as can DMA. There is a chapter devoted to peripherals and tricks for timing and interfacing.

The author does a good job. The diagrams and tables are numerous and excellent. Tracton cleared up some nebulous areas for me.

One warning: The book is mainly a brief outline of how to go about design and construction and offers only the basics of building a complete system. Some previous reader experience in circuitry and computers is assumed. Irritating is that figures referred to in the text are a few pages distant.

What the author says about adding peripherals applies to the whole book: If you have time, money and ambition, forge ahead.

Frank Lawler
Loma Linda CA

Introduction to TRS-80 Graphics
Don Inman
dilithium Press, Forest Grove OR
Softbound, 132 pp., $8.95

Personal computers' ability to draw pictures and other graphic representations interests me, and the TRS-80 is well equipped to do this. While the Level I and Level II manuals explain the mechanism for using TRS-80 graphics, neither goes much beyond the basics. *Introduction to TRS-80 Graphics* by Don Inman is the ideal text for those who would like to really use the graphics capability that Radio Shack built into the TRS-80.

This book is written in textbook form and includes tutorial and demonstration material along with suggestions for further directions of study. It is based on the Level I machine, but all material is pertinent to the Level II TRS-80 as well.

First comes a discussion of the PLOT and PRINT methods of placing information on the video screen. Plotting is emphasized because it is the better method in most cases. PRINT AT is used to place characters at selected screen locations. Many well-commented program examples are used throughout the book to demonstrate the principles explained.

Some of the demonstration programs are plots of mathematical functions, and a few are games. A duck-shooting game shows how and why to use the POINT statement to determine if a given plot position on the screen is turned on or off. Another program draws abstract pictures. Explanation and programming of horizontal, vertical and diagonal lines; simple and complex curved lines; and triangles and other geometric figures are provided.

Exercises for the student are inserted at appropriate places in the text. Each chapter concludes with solutions to these exercises and a list of suggestions for additions or changes to the programs that have been presented.

Introduction to TRS-80 Graphics is structured so that it can be used in the classroom, but it is also well suited to the individual user who wants to get a better grasp of the graphics his machine is capable of. Every TRS-80 owner should have a copy.

Rod Hallen
Tombstone AZ

TRS-80 Assembly Language Programming
William Barden, Jr.
Radio Shack, Ft. Worth TX
1979, 224 pp., $3.95, #62-2006

For you who have been looking for a book on Z-80 assembly language that you can understand, this is it. Unlike many of the assembly-language books on the market, which are extended descriptions of individual op codes, this book deals more with practical applications of assembly language. As the name implies, it uses the TRS-80 and its architecture as the bases of the hardware structure. Several features of the Z-80, such as direct memory access, are omitted because the TRS-80 does not use them.

Assembly language is more difficult to master than BASIC due to its rather cryptic use of registers and close ties to the CPU. But many times there is no other way to achieve the speed, size or I/O operations of an application without resorting to machine language. To add to the difficulty, the binary numbering system must be mastered and then translated into hexadecimal, and you have to do all this before you even arrive at chapter two! Does this mean you must "hex" the machine to make it perform? Not so, claims the author. Many people have successfully mastered assembly language, and so can you.

The book is organized into two sections, with the first covering general Z-80 architecture, instructions and addressing. Almost every page has an illustration to back up the text. It is impossible not to be technical when presenting the assembler; however, the author makes this subject readable and understandable by introducing a little at a time: small sections of assembled code are used throughout the book to illustrate concepts. This makes the flow and functions of statements much easier to follow.

Also, in section one, the author discusses the TRS-80 Editor/Assembler and T-BUG monitor. This book is worth its price for the supplement details provided on these products. The author describes the T-BUG tape format, register locations and loading points for both Level I and Level II. While T-BUG may not be an outstanding monitor, this additional information makes utilization of T-BUG's maximum capability much easier.

Section two goes into more detail on moving data, arithmetic, compare operations, logical and bit operations, strings, tables and I/O operations. This is really the meat of the book. Again, extensive use of practical examples makes for better understanding. One particular item of interest is how the keyboard is scanned and decoded: the addresses of the disk drive, disk controller, line printer and cassette are given. The mysteries of the cassette I/O are exemplified using a small program that plays music.

This book is an excellent nontraumatic introduction to the TRS-80 assembler, as well as a wealth of specific information on the inner workings of the computer. It is a must for those interested in delving deeper into the mysteries of the TRS-80.

Jerry Martin
Columbus OH

Designing Microcomputer Systems
Udo Pooch, Rahul Chattergy
Hayden Book Company, Inc.
Rochelle Park NJ
Softbound, 214 pp., $8.95

In their preface, the authors of this book state: "The purpose of this text is to provide the electronics engineer and the hobbyist with the background information necessary to build microcomputer systems." While I think their approach is inconsistent in places, still they have put together a lot of very useful information. I doubt that many would-be readers will want to build a microcomputer from scratch, but this book will still be valuable to anyone who wants to learn more about the hardware end of microcomputing.

Chapter 1, an overview of microcomputer systems, starts by emphasizing the difficulty of functioning in the rapidly growing microcomputer field unless you have certain basic skills. These skills include an understanding of how the microcomputer operates.

This overview consists of a discussion of both hardware and software requirements and implementation; how the various components work together; and how software is created and used. This is not a detailed treatment, but rather a foundation on which to later build more specific information.

Basic hardware is the subject of chapter 2, which explains how the various components such as ROM, RAM, peripheral devices and timers are used to accomplish required tasks. This chapter also explains micro-programmed microprocessors. Lots of block and timing diagrams are used to help clarify the discussion.

In this early part of the book, I noticed a seemingly narrow view of the microcomputer field. For instance, in explaining software creation in chapter 1, the authors give the impression that assemblers and compilers are the only software tools available. High-level interpreters, the mainstay of hobbyist computers, are completely ignored. In the same manner, the authors indicate that all I/O operations are interrupt

driven, when such is not the case in most small systems.

The next three chapters, which cover the Intel 8080, Zilog Z-80 and Motorola 6800, respectively, come much closer to actual hobbyist practice. After reading chapters 1 and 2, I had decided that the book was really written for the professional engineer—not so much because of the level of the material presented, but because of the way it was described.

Starting with chapter 3, there is a more definite hobbyist feel to the text.

The 8080, Z-80 and 6800 are very well covered. In fact, it should be possible to put together a system using the information provided; but this is good reading even if all you want is a better understanding of the hardware involved. Timing and control signals, interconnections with specific chips and design considerations are provided.

Interfacing is taken care of in chapter 6. The authors start with the philosophy of hardware versus software interfaces: is it better to assign as many tasks as we can to the processor and make the hardware as simple as possible, or is the reverse better? Actually, a compromise based on individual situations is the best choice.

UART, DMA, digital and analog, keyboard, printer, cassette, disk and video interfaces are all well covered; however, the narrowness of the authors' viewpoint again shows up in the video section, which states that "most video displays use a 16 by 32 characters-per-line format." This may have been true three years ago, but today 16 by 64 is by far the most popular hobbyist display, with 24 by 80 dominating the business market. No mention is made in this chapter of the 5 inch minidisk, even though it must be at least as prevalent as its 8 inch big brother.

Although the book's copyright date is 1979, the material doesn't seem to be quite that current—either that, or it is an indication the authors are not directly involved in the hobbyist field.

Chapter 7 concerns the selection and assembly of a microcomputer and appears to advocate kits as the most logical way to acquire a machine. I disagree with the contention that a kit-builder will be able to troubleshoot his computer and the buyer of an assembled product will not. This unnecessarily simplifies the benefits of assembly. Background and experience will play a large role in any troubleshooting attempt.

In spite of the criticisms I have leveled at this text and the authors' approach to it, I still feel that it is a well-written, informative book that will benefit anyone who wants to gain a good background in microcomputer hardware.

Rod Hallen
Tombstone AZ

Computer Accounting Methods
Cook, Wade, Upton
Petrocelli Books
New York NY, 1975
Softcover, 184 pp., $7.50

There is a serious shortage of books to meet the information needs of those of us interested in doing useful business data processing with microcomputers. When I found this book, read the introduction, scanned the contents and sampled a few pages, I thought I was on the right track.

I was wrong.

The plan and structure of the book are good. The execution of that plan, however, is disappointing. The book presents examples of five business accounting systems programmed in a time-shared version of BASIC. The systems presented are General Ledger, Financial Reports, Accounts Receivable, Payroll and Depreciation Accounting. For each of these systems, the authors present a systems flowchart, program flowcharts, program listings, test data and test runs . . . a good plan and structure. To see how the book fails during execution, let's examine each piece of the structure.

The system flowcharts are presented without elaboration. The essential details of the interaction between the user and the programs are hidden in the details of the individual programs. The structure and design of the various transaction and master files are not discussed or even documented. There are numerous alternatives for structuring files that affect the design and coding of the programs in a system. The authors here do not even explain or defend their particular choice, much less examine any alternatives. The system flowcharts that result do no more than identify programs and files at the most rudimentary level.

The program flowcharts and listings are presented side by side in a format intended to make it easy to study the relationship between the two. When we turn to the details of both, however, we find further disappointment.

For example, the flowchart (p. 59) of the program designed to print an income statement appears to have an infinite loop condition that will cause the total of expenses to print over and over until the program runs out of data. After digging into the code for a while, you find that the program actually will work, but only by exploiting a particular feature of the way the General Ledger file is designed. Since this feature is only mentioned in a passing sentence rather than being properly documented, I had to spend 20 minutes deciphering the code and flowcharts. Imagine trying to test such a system if an error occurred!

This brings me to my final objection to this book. Obviously, the systems presented are simple and meant to be illustrative rather than comprehensive examples. Nevertheless, the systems presented represent poor design and programming practices. BASIC, as a language, is not naturally suited to business data-processing needs. Careful attention to detail and a well-thought-out design are required to use BASIC for a large programming system. Yet, as an example, this book does not once mention BASIC's subroutine capabilities.

In summary, I cannot recommend this book. If someone can successfully combine this general approach with a solid presentation of design choices and programming practice, then we may have a book worth buying.

James V. McGee
Claymont DE

The Personal Electronics Buyers Guide
C. Sippl, R. Sippl
Prentice Hall
Englewood Cliffs NJ
Hardbound, 338 pp.

This new Prentice-Hall book by the Sippl brothers is extremely well illustrated. It tries to cover material that really should fill at least five or six books, so the end result is something more like a magazine than an in-depth book.

The Sippls cover—perhaps "lightly skim" is better—personal computers, electronic games, television, solar energy, home security, computers that talk and sing, education and art and communications. They are familiar with their subject, and what there is in the book is well done.

It has been often said that no author should do his own indexing. The index to this book is one of the worst I've ever seen . . . just about totally useless. This is a terrible thing to do to a book whose main value is as a reference to products and ideas. For instance, this weird index has no listings at all under B, G, I, K, L, O, Q, U, X, Y, Z! Yet under V we have a complete page of listings. W has one listing only: "West German Firms." If you want to find anything you've read in this book, you'll just have to thumb through until you find it. Shame on whoever did the index. Shame on the editor of the book, if any (none listed).

The illustrations are all from the manufacturers, which is remarkable. *Kilobaud Microcomputing* constantly pleads for product photographs from manufacturers and infrequently is able to get them.

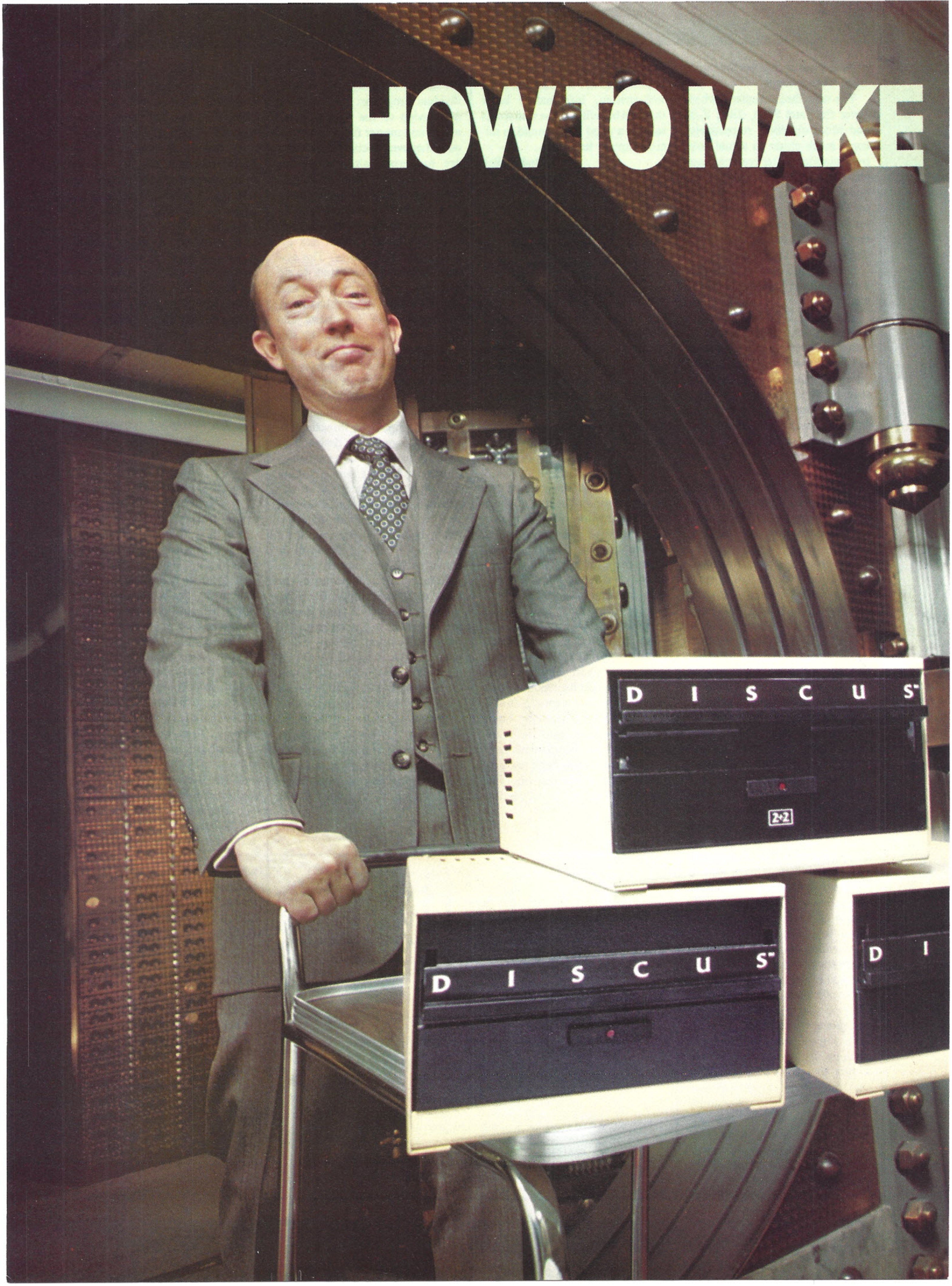
Wayne Green

CONTEST

Over the past year, the following 12 articles have been voted by readers as "the best of the month." Now, it's time to select the "best article of the year." To vote, please enter the *number* (do not spell out the month) of the article you choose on the Reader Service card at the back of the magazine.

1. "Let Your Computer Wear a Watch," Brooks, Oct 1978.
2. "Hey, Kids! It's 'Mickey Modem!'" Gibson, Nov 1978.
3. "The TRS-80: how does it stack up?" Juge, Dec 1978.
4. "TRS-80 Tape Controller, Rowlett, Jan 1979.
5. "It's There—But Where?" Mathis, Feb 1979.
6. "PET User Port Cookbook," Yob, Mar 1979.
7. "A Look at TRS-80 Peripherals," Cowan, Apr 1979.
8. "A Text Formatter in BASIC," Law, Mitchell, May 1979.
9. "'Monitor,'" Hallen, Jun 1979.
10. "IC Logic Tester," Ruckdeschel, Jul 1979.
11. "Machine Language Monitors for TRS-80," Edmonds, Aug 1979.
12. "The Failure of a Micro in Business," Kepner, Sep 1979.

HOW TO MAKE



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PET-POURRI

Len Lindsay

Commodore Word Processor

An excellent word processor for the PET is now available from Commodore. Word Processor II, which costs $99, comes on a diskette; the printed manual is also included in its entirety on the diskette as data files for the word processor. This lets you make copies of the manual whenever you like, and gives you plenty of text to simply load in and try out your new word processor.

The Word Processor II is made to work with a new PET/CBM 16K or 32K computer with the CBM 2040 dual disk and a printer. Two versions of Word Processor II are on the diskette. One outputs the finished text to the CBM 2022 or 2023 Printer; the other outputs to any ASCII printer via the IEEE channel. Word Processor II also relies on a special ROM chip, included in the package, which must be inserted into "position 9 of the circuit board." That means the left-side socket of the three empty sockets in the PET.

Commodore advises you to have your dealer install the ROM; you may void your warranty if you do it yourself. Commodore also has announced a version of this word processor for the 8K PET and is working on an advanced version with enhanced features.

You need an entire manual to explain everything this word processor can do, but I will briefly explain its major points. Basically, it is a character-oriented, direct-cursor editor. Twenty-three lines of text are continuously displayed on your screen (the top two lines are reserved for status indicators). This text scrolls up and down. The INSERT command opens up holes, and all text following it slides down and to the right. It is amazing to watch. With the automatic-repeat key you can move the cursor from one side to the other in about a second.

You can delete one character at a time, a line at a time or a whole section at once. You can insert one character at a time as you type, or you can insert spaces and then type in your word. Whole sections of text can be moved from one section to another. A useful extra function is COPY. You can instantly copy whatever you type on the first line anywhere on the screen simply by typing CONTROL*.

The RVS/OFF has been redefined as the CONTROL key. Pressing the CONTROL key puts you in the Command mode. You then can move sections of text, issue disk or printer commands or switch text areas.

Two separate and distinct text storage areas, called main text and alternate text, allow the use of other features. Variable data can be included in your text . . . excellent for creating personalized form letters. Instead of a name or the amount of money owed your company, you type in a variable block. This text can be stored on disk for future use. The variable blocks can be filled three ways: manually, semiautomatically or automatically.

The automatic method is amazing to watch. You simply switch to the alternate text area and type in the data to be used to fill all the variable blocks. You may type more than one set. For instance, type the data for three sets of the letter. You then can output to the printer, and it will automatically fill in the variables for you, one letter at a time, automatically advancing your paper and beginning the next letter, using the next set of data.

The alternate text area can also be used to hold "canned" paragraphs or sentences, which are numbered. While writing in the main text area, you can call these paragraphs by number, and they magically appear. In this manner, whole letters can be composed from pre-typed paragraphs.

Another useful feature is the SEARCH command. Just put whatever word (or characters) you wish to search for on the first line, and the program will scan your text and place the cursor at the first occurrence of that word. Another command, and you are placed at the second occurrence. This is useful if you wish to change the word "car" to "automobile" every place it is used.

This has been a brief overview of the Word Processor II from Commodore. Remember, you must have a CBM 2040 disk unit and a printer to use the program.

Commodore Printer

Commodore finally has shipped its printer models 2022 and 2023. These dot-matrix printers plug into the IEEE bus. The friction-feed model 2023 seems to be worth the $849 I paid for it. I now can use my own stationery when I print out letters. My stationery is on three-part paper, and I get three clear copies.

The $995 tractor-feed model 2022 has the same features as the 2023 with the addition of variable line spacing. This can be set for six lines per inch, eight lines per inch or for other custom line spacings.

The CBM printer includes its own microprocessor, making it a smart printer. For instance, it can format your output, add a dollar sign in front of your numbers, line up the decimals in a column of numbers or right/left-justify the column. It also can tack on a + or − for positive or negative numbers. The format control is not limited to numerics only. It can format alphabetic output as well as print string constants such as lines.

The printers have a user-defined character that, once assigned, can be printed at any time with a CHR$(254). It can be redefined as often as you wish, but must remain the same within one print line.

Another ability of the printers is to print enhanced characters. You can double the width of any string of characters simply by preceding

```
 0 REM ********************************
 1 REM * EXAMPLE OF USER DEFINED       *
 2 REM * CHARACTER AND ENHANCED        *
 3 REM * PRINTING.                     *
 4 REM *                               *
 5 REM * BY LEN LINDSAY                *
 6 REM *                               *
 7 REM * FOR USE WITH A CBM PRINTER    *
 8 REM * MODEL 2022 OR 2023            *
 9 REM ********************************
 10 REM *** DEFINE USER CHARACTER ***
 20 DATA124,68,95,85,17,17
 25 OPEN5,4,5:REM OPEN FILE WITH SECONDARY ADDRESS OF 5 FOR DEFINING CHARACTER
 30 FOR I=1TO6:READA:A$=A$+CHR$(A):NEXT
 40 PRINT#5,A$:REM THIS SETS UP THE USER DEFINED CHARACTER - CHR$(254)
 42 REM *** CHR$(254) NOW DEFINED ***
 50 OPEN4,4:REM OPEN A SECOND FILE
 60 REM PRINT TO CBM PRINTER
 62 NM$="¬OMPUTER ¬ORNER"
 63 REM PRINT A CURSOR DOWN AT THE BEGINNING OF ANY LINE FOR LOWER CASE
 64 REM CHR$(254) IS THE USER DEFINED CHARACTER
 65 L$="▒"+CHR$(254)+" "+NM$+" "+CHR$(254)
 66 REM PRINT IN NORMAL SIZE
 67 PRINT#4,L$
 68 PRINT#4:REM A BLANK LINE
 69 REM PRINT IN DOUBLE SIZE
 70 PRINT#4,CHR$(1)L$
 75 PRINT#4:REM A BLANK LINE
 77 REM PRINT IN DOUBLED DOUBLE SIZE
 80 PRINT#4,CHR$(1)CHR$(1)L$
 100 REM CLOSE BOTH FILES
 110 CLOSE5
 120 CLOSE4
READY.

⋲ Computer Corner ⋲

⋲ Computer Corner ⋲

⋲ Computer Corner ⋲
```

Listing and run of enhanced printing and user-defined characters demonstration.

Printing Method	Serial Impact Dot Matrix
Print Rate	70 lpm or 150 cps (maximum)
Print Direction	Unidirectional
Column Capacity	80
Character Font	6 × 7
Column Spacing	1/10"—ten characters per inch
2023 Line Spacing	1/6"—six lines per inch
2022 Line Spacing	Programmable
Character Size	.11" high, .10" wide
Copies	3, including original
Ribbon Type	Nylon fiber with eyelets
Ribbon Life	2,000,000 characters
Ribbon Spool	
Type	Underwood
Paper Width	10" computer folded paper
Forms (2022 only)	8.5 + .5 × 2 (sprocket margins)
	Pin to pin distance:
	.5" longitudinally
	9.0" laterally
	5/32" diameter

Table 1.

it with a CHR$(1). Precede it with CHR$(1)CHR$(1) and you get double-double width characters. This feature can be turned on and off any time, even within a single print line. I put together a program that will demonstrate enhanced printing and user-defined characters. See the Enhanced Printing program listing.

Both printers will print the full set of PET graphics and special key characters, in addition to uppercase and lowercase characters. You can also print the reverse of any character. The switching between lowercase and graphics doesn't always occur. Let me know (*not* c/o *Microcomputing*, please) if you solved any of the PET printer mysteries.

Some of the exact specifications of the 2022 and 2023 CBM printers are shown in Table 1. This information is taken from the printers' manuals.

Computerized Role-Playing Game

I have been waiting for a program like this for a long time. Automated Simulations (PO Box 4232, Mountain View CA 94040) has just introduced a 32K PET role-playing game (RPG), complete with four data files, called Temple of Apshai. It is the first in a series called Dunjonquest (pronounced dungeon quest). This real-time game has beautiful graphics. Price is $24.95.

Automated Simulations explains the game in their brochure this way: "Explore the ruins of the ancient Temple of the god Apshai. Wrest golden treasures from the grasp of hideous monsters. Delve ever deeper into the forgotten labyrinth as you grow into a warrior of heroic prowess!" If you do not understand what RPG is, the manual explains it in easy-to-understand terms. Part of this introduction goes like this: "Role-playing games allow you a chance to step outside a world grown too prosaic for magic and monsters, doomed cities and damsels in distress . . . and enter instead a universe in which only quick wits, the strength of your sword arm and a strangely carved talisman around your neck may be the only things separating you from a pharaoh's treasure—or the mandibles of a giant mantis."

Role-playing games try to simulate fantasy worlds in as realistic a manner as possible. Many details are involved. Traditionally, an RPG involves several people, many rule books, encounter and battle charts, etc. The PET is a capable computer, and it will keep track of all the rules, charts, battle sequences and such details.

I will explain the six basic attributes (three physical, three mental) used to give a unique and distinctive character to you, a Dunjonquest adventurer.

Strength—determines how strong your character is . . . how much weight (of treasure and equipment) he can carry. It also controls how heavy a weapon he can wield and how much damage one of his blows will do to his foe.

Constitution—a measure of health and endurance. It is your general physcical fitness. With a high constitution you can run farther without collapsing and sustain more wounds before dying. This may be the single most important attribute.

Dexterity—your coodination, reflexes and eyesight. A high dexterity gives you an edge when you use weapons and protect yourself with your shield.

Intelligence—your "left brain" intelligence. With a high intelligence you can bargain better, and working magic will be easier (once you find the magical items).

Intuition—your "right brain" functions: getting an answer from "inadequate" data, ESP and luck. With a high intuition you are more likely to find secret doors and discover a trap. With a low intuition you might be doing well to find an open door without a signpost.

Ego—a measure of your mental toughness and willpower. A strong ego can influence others more easily and will fight fiercely despite its wounds.

The first time you play, the computer will randomly chose your level, from a low of 3 to a high of 18, for each attribute. In manual RPGs, you roll three dice to determine the level. You then give your player a name, receive some silver pieces to spend on equipment, and you are off.

You begin at the inn, where you buy your weapons and armor. You bargain with the innkeeper over the price. Then you enter the "pit."

You begin your adventures in the first of over 200 rooms in one of four levels. The lower levels are harder and more challenging. Rooms are quite big, and you move around them in search of treasure (watch out for trapdoors). You can move up to nine steps in one turn. You move in the direction you are facing. You have the option of turning right, left or about face. The faster you move, the more you tire. Also, the more weight you carry, the more it adds to your exhaustion. This also depends on your strength and constitution. If you meet a monster and you are tired, you will not fight as well.

You can deal with monsters in several ways. You can talk to them, which is risky, run away, if you can make it, or attack them. You may shoot arrows at them or attack them (only from close range). Several methods of attack are available. You gain experience for successfully killing a monster. As your experience accumulates you become a better fighter.

After wandering about for some time, you should leave the "pit" and return to the inn. There you collect money for all your treasures and note your experience points. This brings up one major advantage RPGs enjoy over other games. If your character survives, he is still alive. Simply jot down his qualities, experience, riches and equipment. The next game, you may feed this "data" into the PET when you begin and use the character. You will know your "alter ego" quite well and begin to identify with him. You will realize that he is a lousy shot with bow and arrow but swings a mean sword. Best of all, you can take this same character to other RPGs. Instructions are included on how to do this.

Dunjonquest is quite an experience. I rate it as one of my favorite PET programs. One warning though: be ready to THINK! This is not a simple video game. Be prepared to quickly change strategies as they backfire. And one last consoling point: you will be happy to know that if your character dies, there is a good chance that the wizard will find and "resurrect" him—for a fee, of course. But then, your character may be devoured first. You must play to find out for yourself.

Real Time + Graphics + Sound

Fantasy Games Software (PO Box 1683, Madison WI 53701) has done it again. Their first game, Swordquest, was fine. Their second game is even better. Titled Escape from the Death Planet, it is an exciting action game with good graphics, sound effects and real-time programming. The price is $12.95.

The game has a simple plot: rescue the princess and escape from the death planet (make it through four rooms filled with imperial storm troopers and killer robots). Though it sounds like any other game, it is not. The graphics include animated laser fire and explosions. Have heart if you never seem to be able to win. The instruction manual explains how to modify the program to make it a bit easier (or harder). This game will work on both old and new PETs (specify which when you order).

PET Program Structure

If you own a PET, you probably use software purchased from one place or another. You may also have dabbled in writing some programs in PET BASIC. As an aid for beginner programmers, I have outlined a structure for your programs that will allow a bit of organization. It will help you remember to include a POKE-

```
0 PT=PEEK(50003):REM DETERMINE WHICH TYPE OF PET THIS IS
1 REM *** PROGRAM NAME ***
2 REM *** PROGRAM AUTHOR ***
3 REM *** DATE / VERSION ***
4 REM *** COPYRIGHT NOTICE ***
5 REM *** LINES 5 - 9 OTHER COMMENTS ON PROGRAM ***
9 REM *** SET CORRECT MODE IN LINE 10
10 POKE59468,12:REM SET CORRECT MODE - GRAPHICS (12) OR LOWER CASE (14)
14 REM *** RANDOMIZE AT LINE 15 ***
15 XQ=RND(-TI):XQ=0: REM RANDOMIZE - SEED RANDOM GENERATOR
19 REM *** CLEAR THE SCREEN ***
20 PRINT"♥":REM CLEAR THE SCREEN BEFORE STARTING
24 REM *** CLEAR VARIABLES ***
25 CLR:REM CLEAR VARIABLES
29 REM *** DIM STATEMENTS LINES 30-39 ***
30 DIM A(20):REM DIM STATEMENTS IN LINES 30-39
39 REM *** FUNCTIONS DEFINED IN LINES 40-49 ***
40 DEF FNR(N)=INT(RND(1)*N+1):REM FUNCTIONS DEFINED IN LINES 40-49
49 REM *** ASSIGN STANDARD STRINGS & VARIABLES (& DEFAULTS) - LINES 50-69 ***
50 XD$="QQQQQQQQQQQQQQQQQQQQQQQQQ":REM 25 CURSOR DOWN
53 CR$=CHR$(13):REM CARRIAGE RETURN
54 DV=3:REM DEVICE NUMBER
69 REM *** DISABLE STOP KEY ***
70 SL=537-393*PT:DL=136-87*PT:POKE SL,DL:REM DISABLE STOP KEY
72 REM *** THIS ALSO MESSES UP THE TIME FUNCTION - A LONGER ALTERNATIVE IS
73 REM*** AVAILABLE IN MACHINE LANGUAGE
80 REM *** GOSUB TO SET THE PET TIME TO CORRECT TIME ***
85 REM *** GOSUB TO SET AN ALARM / TIMER ***
90 REM *** ASK IF INSTRUCTIONS ARE NEEDED - IF SO GOSUB TO INSTRUCTIONS ***
100 REM *** PROGRAM STARTS AT LINE 100 ***
101 REM ***
102 REM *** IF THE USER BREAKS OUT OF THE PROGRAM
103 REM *** GOTO 100
104 REM *** WILL GET HIM BACK INTO THE PROGRAM
105 REM *** ALL VARIABLES INTACT
10000 REM *** SUBROUTINES START HERE
10100 REM *** THEY BEGIN AT INTERVALS OF 100
READY.
```

PET Program Structure Outline.

59468,12 at the beginning to ensure a graphics mode and will help you later on. Use this structure, and all your programs will dimension the arrays in the same place (lines 30-39). Always start at line 100. A GOTO100 will always get you back into the program if you accidentally break out. The PET Program Structure Outline is in the public domain. Feel free to photocopy it and pass it out at your PET meeting. It may be reprinted with due credits given.

Line 0 is a good place to put the line that allows your programs to determine which PET (old or new) it is running on. A new ROM PET will set variable PT = 1. The old ROM PET will set PT = 0. This variable may be used within your programs that employ POKE or PEEK commands, allowing them to work on either PET. See my article in *Kilobaud Microcomputing,* July 1979, page 72, for detailed information on how to use the PT variable with your programs.

Each of your programs needs to have some identification. Use lines 1-9 for this purpose, either as remarks or as PRINT statements. It is important to make sure that your program is running in the correct mode. Do not assume that the PET begins in the graphics mode. To get the graphics mode, use:

```
10 POKE 59468,12 : REM GRAPHICS MODE
```

or use:

```
10 POKE 59468,14 : REM LOWERCASE MODE
```

Line 15 can be used to seed the random generator. Later in the program you can use RND(1) to get a random number. Remember to reinitialize the variable you use to seed the generator.

Clear the screen with line 20. Get a fresh start with your program.

Line 25 clears the value of all variables. It is not needed but does assure you all variables are cleared.

Lines 30-39 can be used to dimension your variables. This should always be done in the beginning of your program. Since a DIM command is executed twice for the same variable, it causes a re-dimensioned error. You can dimension several variables all on the same line with the same DIM command. See Example 1.

Lines 40-49 can be used to define your functions used in the program. Functions are useful for repeated calculations and formulas. Sample functions are shown in Example 2.

Lines 50-69 can be used to assign variables and strings that will be used throughout the program. For example, to get the cursor to any point I want on the screen, I use two strings. D$ is 25 cursor-downs and R$ is 40 cursor-rights. See Example 3. It is easy to use these two strings along with the LEFT$ command. A simple example of going to the ninth character position of the fifth row on the screen is shown in Example 4.

Other standard variables can be set in lines 50-69. For example, you may wish to set a variable to stand for a carriage return or quote symbol. You also may wish to identify your logical file and device numbers with variables for ease of modification later. See Examples 5 and 6.

Line 70 can be used to disable the stop key if you wish to do so. The simple one-line method works on either PET but does have side effects such as messing up the PET internal clock (TI$ and TI). See Example 7. If you need the correct time in your program, use a subroutine to ask for it and have line 80 GOSUB to that routine.

If you allow a timer or alarm option, line 85 can GOSUB to the routine that sets it. This is handy in games that seemingly last forever. Tell the PET to let you know when

```
30 DIM W(3), N$(3,3), D5(25) : REM DIMENSION VARIABLES
```

Example 1.

```
40 DEF FNR(N) = INT(RND(1)*N + 1): REM NUMBER BETWEEN 1 AND N
41 DEF FNS(N) = INT(100*N + .5)/100: REM ROUND TO 2 DECIMAL PLACES
```

Example 2.

```
50 D$ = "(25 DOWN)": REM 25 CURSOR DOWN
51 R$ = "(40 RIGHT)" : REM 40 CURSOR RIGHT
```

Example 3.

```
200 X = 9:Y = 5:PRINT"(HOME)";LEFT$(D$,Y);LEFT$(R$,X); :REM POSITION CURSOR
```

Example 4.

```
60 CR$ = CHR$(13) : REM CARRIAGE RETURN
61 QU$ = CHR$(34) : REM QUOTE SYMBOL
62 IL = 1 : REM INPUT LOGICAL FILE NUMBER
63 OL = 2 : REM OUTPUT LOGICAL FILE NUMBER
```

Example 5.

```
64 ID = 1 : REM INPUT DEVICE NUMBER
65 OD = 2 : REM OUTPUT DEVICE NUMBER
```

Example 6.

```
70 SL = 537 – 393*PT:DL = 136 – 87*PT: POKE SL, DL : REM DISABLE STOP KEY
```

Example 7.

one hour is up (so you can get back to work). The PET can then blink your screen on and off a dozen times or sound an alarm on your speaker when the time is up. Once the alarm is set, simply check it every move or at some periodic interval.

Line 90 can ask the user if instructions are needed. If so, GOSUB to your instructions. Your program should begin at line 100. A good way to start is with a menu of choices (instructions again, start game, reenter old game).

All subroutines should start at 10000 and always begin at an even 100 interval (i.e., 10100, 10200, etc.).

I hope these guides will be useful in your programming efforts. Let me know of your ideas. Write to Wisconsin, please—*not* Peterborough.

PET Gazette Changes

The *PET Gazette* has changed, for the better. Its phenomenal growth caused a crisis for its one-man operation. Small System Services (PO Box 5119, Greensboro NC 27403) is now the publisher, and the name has changed to *Compute, the Journal for Progressive Computing*. The fall 1979 issue will be over 100 pages, completely typeset on magazine stock. It should now be available from most dealers as well as from overseas distributors. It still carries excellent info about the PET and, additionally, has reviews on other 6502 computers such as Atari, Apple, KIM, SYM, AIM and OSI. Each issue will have special feature articles written by the leading names in the field. Beginning with the January/February 1980 issue, it will be published bimonthly. Subscriptions are $9 per year. Write to *Compute* to subscribe or to get more information.

Programma Progressing

Last spring I advised all PET users to watch Programma International, and that I saw good things coming. Well, I just received a box full of their professionally packaged progams. The list goes on and on.

For $19.95 you can get a good word processor, one of the simplest that I have seen. It may take you one minute to learn to run it, and it does everything you probably need on either PET and any printer (printer, which is optional, can print the final text on the screen). Make sure to specify what printer you have, what type of ROMs you have and your PET serial number if you order this one.

Remember, Programma is the company that markets FORTH (another programming language) for the PET and distributes the final version of Hunt, an excellent program I have explained in past issues. Now you can add about 50 more programs to the list for the PET. Contact Programma International, 3400 Wilshire Blvd., Los Angeles CA 90010.

Moving Sign Billboard

Zephyr Software (PO Box 713, Bonita CA 92002) has created a beautiful set of large three-dimensional-looking alphabet, numbers and punctuation for the PET. They put this together with a program that will print any message up to six lines long continuously across your screen, rolling smoothly from right to left. The price is right—$6.95!

Pet Reference Card

There now is a handy reference card that should be of great use to any PET programmer. Leading Edge Computer Products (4471 Santa Monica Blvd., Los Angeles CA 90029) sells these on heavy paper for $2 each. They include explanations of BASIC and monitor commands. PET's character set is also shown with corresponding CHR$, RVS and OFF numeric equivalents. There's more: IEEE devices, status byte (ST), general info, special symbols, BASIC abbreviations and useful memory locations.

The Other Side

Since the appearance in this column of remarks critical of Microsette tapes, we have learned that many Microsette tape users are extremely satisfied with the product. An unsolicited sampling of their comments to the Microsette company follows.

"I am quite pleased with the last order of cassettes I ordered from you and would like to place another order."

"I have tested one of the cassettes and found it to be of high quality."

"You seem to have a quality product at a reasonable price."

"You have a fine-quality cassette. I'm pleased."

Len Lindsay
Room 6
1929 Northport Drive
Madison WI 53704

CLUB NOTES

Philadelphia PA

The Philadelphia Area Computer Society (PACS) PET User Group meets the third Saturday of every month at 11 AM in the Science Building, La Salle College, 20th and Olney Ave., Philadelphia PA 19141. You needn't be a member of PACS to attend.

Tucson AZ

Meeting the second Friday of each month at 7830 E. Broadway is the Pima Community College Computer Club (PC↑4). Most members have already purchased systems, but those still searching for the best buy are welcome, as are nonstudents. Contact Mike Blicharz (602) 749-9157 or Saul Levy (602) 793-0670.

Waukegan IL

"Dental Computer Newsletter" is available (monthly) to all professionals at no cost. The group offers current information, educational programs and a software exchange. Send six self-addressed stamped envelopes to E. J. Neiburger, Editor, 1000 North Ave., Waukegan 60085.

Toronto, Ontario

Tentatively, all meetings of APPLE-CAN, the Apple-Canada User's Group, will be held at 7:30 PM on the first Wednesday of every month at the Computerland/Toronto store, 2180 Yonge St., Toronto, Ontario, Canada. For more information, contact Peter R. Zacharkiw, acting-president. (416) 485-6700.

Portland OR

NW PET Users' Group is trying to locate people in the Oregon/Washington area who are interested in participating in the group. For information, contact John F. Jones, 2134 NE 45th Ave., Portland OR 97213. (503) 281-4908.

Honolulu HI

Honolulu has its own Apple users' group. Honolulu Apple Users Society (HAUS) supports a newsletter and holds monthly meetings the first Monday of each month at the Honolulu Computerland. Annual dues of $10 include the newsletter. HAUS is interested in exchanging information and software with other clubs. Contact Bill Mark, 98-1451-A Kaahumanu St., Aiea HI 96701. (808) 488-2026.

Albany/Schenectady NY

CAMS, the Capital Area Microcomputer Society, holds meetings the second Wednesday of each month. Contact Stanley L. Mathes, Box 348, Ridge Rd., R2 #1, Scotia NY 12302, (518) 372-3767, for more information.

Redwood City CA

Processor Tech may be gone, but Proteus, a Sol users' group, isn't, according to Dr. Bruce Evans of Pickering, Ontario. Proteus publishes a bimonthly newsletter, and their address is 1690 Woodside Rd., #219, Redwood City CA 94061.

LETTERS TO THE EDITOR

More from Morr

Thanks to everyone who responded so kindly to my article, "Teleprinter Output for TRS-80," which appeared in the August 1979 issue of *Microcomputing*. One minor problem has been noted by a couple of correspondents: the software does not count space characters in determining when to automatically insert a carriage return/line feed when a maximum line width is exceeded. Fortunately, a simple modification will correct the problem: replace memory contents of locations 7ECC to 7ECE from C3, 68, 7F to F5, 18, 70. This modification changes line 500 to read PUSH AF followed by JR CONT, instead of JMP PRINT as shown in the listing.

Many people have written and called regarding the availability of a similar program that interfaces to an ASCII Teletype such as the ASR-33 using the same hardware interface. I have such a program and will sell a copy of it with "how to use" documentation for $6 plus $1 for postage and handling. If you are interested, send a money order specifying your memory size and whether you have a disk-based system or not.

David G. Morr
6599 Red Fox Rd.
Reynoldsburg OH 43068

73 to "80"

I've been following Wayne's articles and magazines since the *CQ* days, and have never been disappointed. Having recently purchased a TRS-80, I was looking for a magazine that would provide for my needs. I subscribe to *Microcomputing*, and now, you are publishing a new magazine, *80 Microcomputing*. I also subscribed to that one. I wish you every success with the new magazine, and I know that I will not be disappointed with it.

Ron Cheshire
Ridgecrest CA

Cover to Cover

About a year ago I decided I was subscribing to too many periodicals. One I decided to keep was *Kilobaud Microcomputing*. Among other things, I liked the cover, which showed a seriousness of purpose.

CONTENTS
Microcomputing, September 1979

Unfortunately, your covers have gone downhill ever since. Please note how I have modified the September cover. I wish you would go back to the old-fashioned table of contents on the cover. I see *Microcomputing* as a practical tool, not a display for fancy double-exposure photography.

Roger W. Berger
Ames IA

I've enjoyed the new covers. They make for a "slicker-looking" magazine. I know it's a lot to hope for, but one of these days I figure we might be shocked with a picture of "good ole what's his name" behind the plain brown wrapper! How about some of the other staff as well?

Perhaps the most important reason I wrote is this: within the last two years, probably a dozen magazines for the TRS-80 have appeared (and disappeared); I recently learned of your intentions in that area.

I'm appalled at the prices some people are charging for their mag, especially considering the dubious content. A typical example: the cover headlined "DOS Shortcuts." This amounted to the optional "TO" in the TRS-80 Rename and Backup functions . . . at least a hundred keystrokes saved per year! There's a new magazine being published that doesn't offer even this!

My point behind all this? I appreciate all the fine software you have published in the last year. I appreciate errata when it's necessary. I appreciate, in general, the efforts of *Microcomputing* to aid the progress of microcomputing, both on a personal and business level . . . no easy task! I have confidence your new publication, *80 Microcomputing*, will represent the usual quality of other 1001001 publications.

Charles Butler
Lansing MI

Praise Where Praise Is Dual

When we met Wayne in Paris, he suggested we contact you if we had any problems with companies advertising in your magazine. Far from complaining, we have to compliment one of your advertisers: Mumford Micro Systems.

We telephoned Mumford Micro Systems on the 30th of August, and today (Sept. 4) we received the goods ordered and the documentation, which was completely clear and understandable.

In ordering similar items we normally expect delivery to take at least 12 weeks; in one case we received delivery six months after we placed the order.

We have nothing but praise for this firm and feel that this praise should be expressed in your column.

John Barton
Rostronics Ltd.
London, England

I like to give praise where it is due. In this (micro) game, false promises and rip-offs have been so common that it is the "good guys" we have to single out for special mention, instead of the bad guys. For example, the great customer service of such organizations as Godbout and Ithaca Intersystems has become famous. I want to give yet another example: Percom Data.

Percom is only one of many vendors advertising compatible disk drives for the TRS-80. Some vendors can deliver, and some hedge. Percom has a toll-free number for inquiries and orders. The lady handling this chore is pleasant and intelligent, and knows about the merchandise. Percom tells you, up front, what they have and when you can have it (usually right away). If you call about an order, they can find it immediately and give you the status without excuses. And when it arrives, it works.

The industry would benefit if all suppliers realized that the majority of customers judge them by the person on the other end of the phone or by written correspondence, almost as much as by their merchandise. In this case the merchandise is also excellent.

Ernie Brooner
Lakeside MT

Tele-Foner

I have just finished reading Mr. Derynck's article, "Bit Rate

(see Letters, page 23)

NEW PRODUCTS

Edited by Dennis Brisson

PASCAL/M

PASCAL/M is a CP/M-compatible PASCAL that combines the language power of PASCAL with the extensive file-handling capabilities of CP/M. PASCAL/M allows full access to CP/M data files written in other languages (such as BASIC) and stored under CP/M. All CP/M utilities are available for managing PASCAL programs and files. All I/O is fully compatible with the CP/M file structure. You can invoke PASCAL programs in CP/M SUBMIT files. Built-in procedures provide for terminal-independent cursor controls.

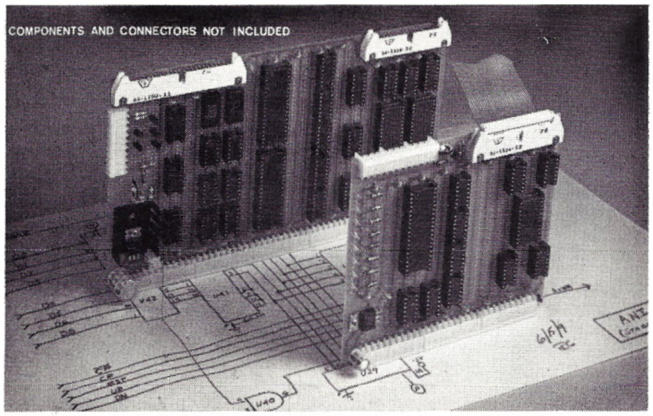
Standard PASCAL/M is available for the 8080/85 or Z-80 CPUs. A special Z-80 version takes advantage of the Z-80's extended instruction set. The package includes diskette with P code compiler, interpreter and runtime library; "PASCAL User Manual and Report" by Jensen and Wirth; and "PASCAL/M User's Reference Manual." It is available on 5 1/4 or 8 inch diskettes. Price is $350; for manuals only, $35.

Digital Marketing, 2670 Cherry Lane, Walnut Creek CA 94596. Reader Service number D63.

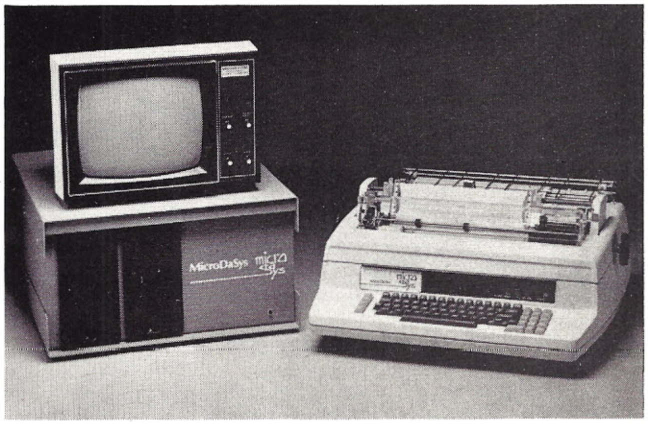
SS-50 Prototyping PC Boards

Percom Data Company, 211 N. Kirby, Garland TX 75042, has added two models of prototyping boards for 6800/6809 computers to their SS-50 bus product. The larger of the two cards fits the standard SS-50 bus, and the smaller card fits the SWTP I/O bus. The boards accommodate 14-, 16-, 24- and 40-pin DIP sockets and have conveniently located contacts for power regulators.

Up to 70 14-pin sockets may be installed on an SS-50 bus card, and the I/O card, which is 1 1/4 inches higher than the standard SWTP I/O card, will accommodate up to 34 14-pin DIP sockets. Both a 34-pin and a 50-pin ribbon connector may be mounted on the top edge of the SS-50 bus board, and a 10-pin Molex connector may be mounted on a side edge. The I/O size card accommodates a 34-pin ribbon connector and a 12-pin Molex connector on the top edge. Molex connectors are used on the bus edge of both cards. The SS-50 bus card costs $24.95, and the I/O card is $14.95. Reader Service number P67.



Percom's SS-50 bus card and I/O card.



System-Z.

Data Entry Keypad System

Have you ever been faced with an application in which a numeric pad wasn't enough and a full size keyboard was too large or inconvenient? Gimix, Inc., 1337 West 37th Place, Chicago IL 60609, has the answer for you: a 35-button remote keypad system for data entry.

The keypad has 34 data keys and a shift key arranged in a 5 × 7 matrix. Each data key generates two distinct codes, depending on the status of the shift key. Press shift once, and the next character sent will be shifted. Press shift twice, and the shift locks on until cleared. It also has a time-out feature that sends a code approximately 15 seconds after the last key entry. This feature can be used to prevent system lockup caused by incomplete or unfinished data entry.

Since the keypad generates binary code, keytop layout is user-definable, and a simple software lookup routine can be used to convert to any desired code. It can be interfaced to almost any computer system through an RS-232 serial port. The standard baud rate is 75, with 300 baud available as an option. The system requires 15-18 volts ac at approximately 80 mA. Cases (3 1/2 × 4 1/2 × 1 1/2 inches) come in various colors in either wood ($118.82) or acrylic ($128.82). Reader Service number G28.

Word Processor and Business System

The System-Z word processor and business system is billed as a fast-typing secretary, careful accountant, efficient order taker, friendly gamesperson and serious on-line computer system from MicroDaSys, PO Box 36051, Los Angeles CA 90036. It features the Z-80 processor, S-100 bus, CP/M Disk Operating System, a full-sized disk drive (standard), 32K RAM, basic printer I/O, a fully encoded ASCII keyboard, CRT video monitor and software. It can type your letters and do rewrites at over 600 words per minute—you control your printing parameters.

The System-Z comes with a comprehensive user's guide that explains system setup, CP/M commands, standard operation, troubleshooting aids, as well as hardware specifications. Hardware and software options available for the system include full-color video graphics display using MicroDaSys' new 80 × 24 ColorMaster video card, hard disks and additional floppy disks. Reader Service number M110.

Speech Device for the Nonverbal

Now you can open up a new world of communication for children and adults who do not have oral communication abilities with the Phonic Mirror HandiVoice, a handheld electronic voice synthesizer that can produce virtually any word in the English language. The speech output is based on prestored sounds, words and phrases that can be combined into sentences, recalled and repeated.

Two models of the HandiVoice are available to accommodate the wide range of physical disabilities and cognitive needs: the Model HC 110 features a lap-board style for pre-language or developmentally disabled persons. It uses selectable overlays with words, graphics or symbols. The Model HC 120 looks and operates like a calculator. All selections are accomplished through three-digit numeric coding. Both units are lightweight, portable and operate on rechargeable batteries. Price is $2195 for either model.

The Silent 700 data terminal.

HC Electronics, Inc., 250 Camino Alto, Mill Valley CA 94941. Reader Service number H48.

Heath Computer

The WH89 is an advanced-design, all-in-one, 8-bit, compact desktop computer system that has 16K RAM expandable to 48K memory. The unit includes a professional 25 line by 80 character CRT with full keyboard and numeric pad, two Z-80 microprocessors and a built-in 5 1/4 inch floppy disk. It is offered with an assortment of software packages, including word processing, Microsoft BASIC and FORTRAN. Price is $2295.

Heath Company, Benton Harbor MI 49022. Reader Service number H5.

Bubble Memory Terminals

Texas Instruments, PO Box 1444, Houston TX 77001, has recently announced two new Silent 700 data terminals using TBM 0103 magnetic bubble memory: the Model 765 Portable Memory Terminal and the Model 763 Memory Send-Receive Terminal. The 765 terminal (17 lbs.) is designed for portable use and includes a carrying case and built-in acoustic coupler. The tabletop version, the 763 terminal, is designed for office applications where portability is not required.

These magnetic bubble memory units have several advantages over media such as cassettes, paper tape or floppy disks: electronic reliability, higher access speeds, smaller size, less weight and power consumption. Terminal applications can use data entry during daily use, off-line from the host computer. The stored data then can be transmitted to the home office computer over standard telephone lines at a speed of 30 characters per second (300 baud) via the built-in acoustic coupler on the 765 terminal or at 120 characters per second (1200 baud) with either terminal when connected to an external modem. Prices for the units with 20K bytes of bubble memory are $2995 for the 765 and $2695 for the 763. Both terminals are expandable to 80K bytes of memory at $500 per 20K byte increment. Reader Service number T73.

TRS-80 Minifloppy Disk Drive

The MF-80 minifloppy disk drive for the TRS-80 is directly compatible with all Radio Shack TRS-80 software and hardware. It consists of the MPI B-51 drive and a heavy-duty power supply enclosed in a silver case. The B-51 drive features 40 tracks, dust-tight door and diskette eject. The B-51 has the longest clutch in the industry, which prevents crimping the center hole of the diskette. The rugged case is vented to prevent heating problems. Price is $359.

Cost Effective Computer Services, 728 S. 10th St., Suite #2, Grand Junction CO 81501. Reader Service number C124.

Malibu Printer

The Model 165 Malibu printer can be operated in three modes: as a high-speed dot matrix printer at 165 characters per second (cps); a reduced speed, letter-quality dot matrix printer at 90 cps; or a full-graphics matrix printer. This versatility has been demonstrated in such applications as computer portraits, custom character sets (Japanese, Katakana, music symbols, etc.) and high-density characters for word processing. (Complete dot control is provided for 60×72 dots/inch). With the introduction of a new interface card for the Apple computer, the "Graphics Printer" can be teamed up with the perfect mate, the "Graphics Computer." (Other optional interfaces include a serial RS-232/ASCII parallel controller card and an S-100 bus I/O card.)

Model 165 features include: underlining, expanded characters, programmable horizontal and vertical tabs, selectable left margin, easy user-adjustable platen (up to six-part forms) and a time-delay feature that shuts off the fan when the printer is idle. Price is $2395.

Malibu Design Group, Inc., 8900 Eton Ave., Suite G, Canoga Park CA 91304. Reader Service number M122.

6502 PDS

The 6502 PDS (professional development system) is a complete professional microcomputer laboratory utilizing the standard S-100 bus. The system features the CGRS 6502/S-100 MPU board. Additional boards in this multi-card computer consist of the CGRS multiple I/O board, an S-100 disk controller board and a 16K RAM board. All boards are mounted in a ten-slot S-100 mainframe, leaving ample room for future expansion and experimental hardware.

The 6502 PDS includes the CRS-DOS operating system and comes with dual, 5 inch minifloppy ($2500) or dual, full size (8 inch) floppy disks ($3300). Options include a hardware DMA front debug panel, nine-digit BASIC interpreter, Pragmatic Designs DBM-1 ROM simulator and an internal video terminal. A set of manuals is available separately for $25.

CGRS Microtech, PO Box 368, Southampton PA 18966. Reader Service number C116.

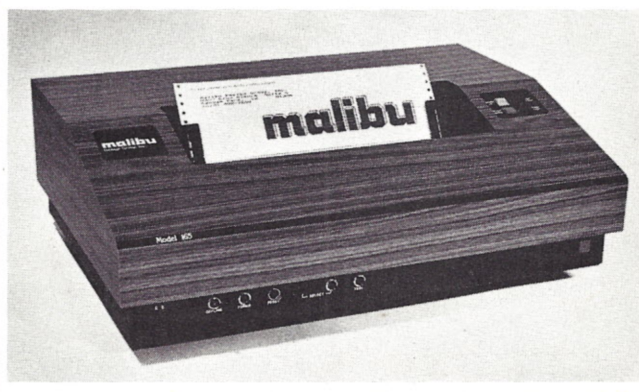
Payroll Program

A simple, comprehensive payroll program for up to 115 employees is now available from the V R Data Corp., 777 Henderson Blvd., Folcroft Industrial Park, Folcroft PA 19032. The Level II, two-disk, 32K program provides for federal withholding tax, FICA and state, as well as local, taxes—customized to your particular location. It can even deduct sick pay from FICA.

The program also has the capability to produce monthly, quarterly and year-to-date reports. It can be custom-tailored for individual payroll periods—weekly, biweekly, semimonthly and monthly. Random access allows an operator to punch up an employee's name at any time, and it's designed for an operator to change any one of the 44 individual fields. The system is also programmed to print checks and stubs to guarantee exact records. Price is $99.95. Reader Service number V19.

Tarbell Dual Disk Drive

The VDS-II Vertical Disk Subsystem includes two Siemens 8 inch disk drives, Tarbell floppy disk interface, CP/M disk oper-



Model 165.

ating system and Tarbell BASIC. The VDS-II is a Shugart-compatible, single-density, single-sided dual-drive system that uses standard IBM-compatible soft-sectored 8 inch diskettes. Capacity per drive is 256K bytes, with a 250 kHz transfer rate.

The Tarbell floppy disk interface plugs into any S-100 bus computer. The 32 byte ROM bootstrap program is automatically implemented using the RESET switch and switches off when the bootstrap is completed. Four extra IC slots on the board provide additional flexibility, and on-board circuitry permits the addition of up to four disk drives.

The CP/M includes such capabilities as Batch Processing, Text Editor, Assembler, Debugger, Compiler, copy capabilities and peripheral interchange. Tarbell BASIC runs on 8080, 8085 or Z-80 CPUs. The system package includes a cabinet with fan and power supply, cables and connectors and complete hardware and software documentation. Price is $1888. All components, however, are available individually including the cabinet alone or cabinets for one or three drives.

Tarbell Electronics, 950 Dovlen Place, Suite B, Carson CA 90746. Reader Service number T11.

Heathkit Extender Board

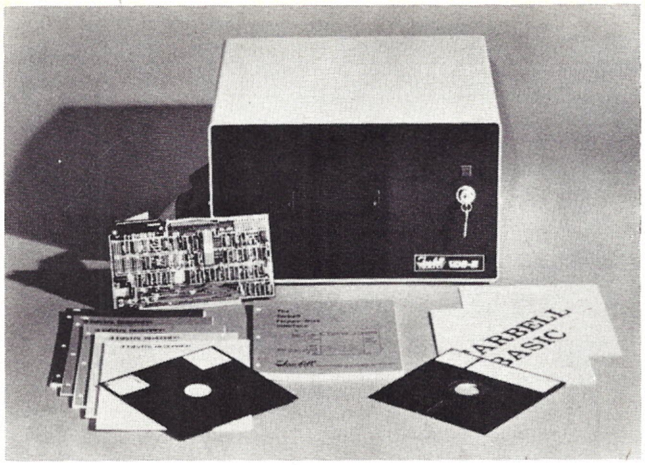
The Heathkit extender board for the H8 computer is a sturdy 3/32 inch FR-4 PC board, double-sided, with plated through holes and solder plate traces over 1 oz. copper. It contains a Molex, 25-pin edge connector with formed leads for easy scope-probe attachment. The self-adhesive edge connector label identifies each signal location.

The H8 Extender Board allows Heathkit owners to troubleshoot their machines faster and easier, because each board is up above the computer for complete access to all circuits and components. Jumper links in power lines (+ 8 V, ± 18 V) makes power measurement simple. In addition, the links can be replaced with fine copper wire, which will protect the traces of the motherboard from damage due to excessive current during testing. The price of the ready-to-assemble kit is $39.

Mullen Computer Products, Inc., Box 6214, Hayward CA 94545. Reader Service number M32.

Card Cage

Prototek, Inc., PO Box 46512, Cincinnati OH 45246, announces its new Series 105 prototyping system, which is S-100 bus compatible. The Series 105 modular 9½ inch card cages can be ganged to fit a standard 19 inch rack. The aluminum card cage features dual card packing densities of 11 cards at .6 inch spacing or five cards at 1.2 inch spacing. Bused printed circuit and wire-wrappable card cage backplanes are available. Both backplanes are 1/8 inch G-10 epoxy glass. All bused signals are terminated with 1k Ohm pullups. A motherboard-based 5 V dc regulator is supplied to provide the termination voltage.



The VDS-II.

The CWA-105P kit includes the card cage metal work, PC backplane, 5-dual, 50-position PC card edge connector, 1-5 V dc regulator, 5-10 uF decoupling capacitors, ten 1k Ohm SIP packs, four 1k Ohm resistors, one power connection post, assorted mounting screws and ten plastic card guides for $155. The kit may be purchased without the metal work, screws and card guides for $95. Reader Service number P74.

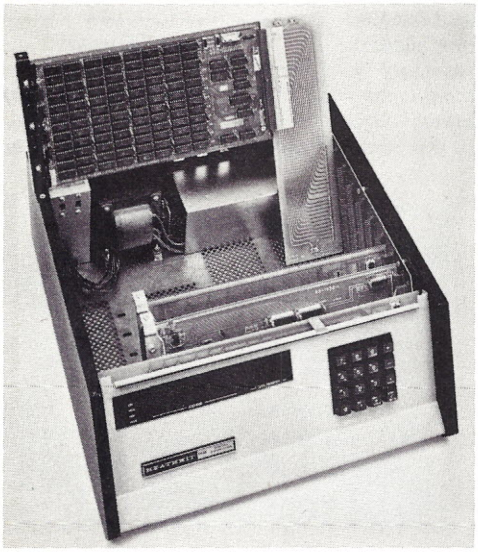
6800 Star-Kits

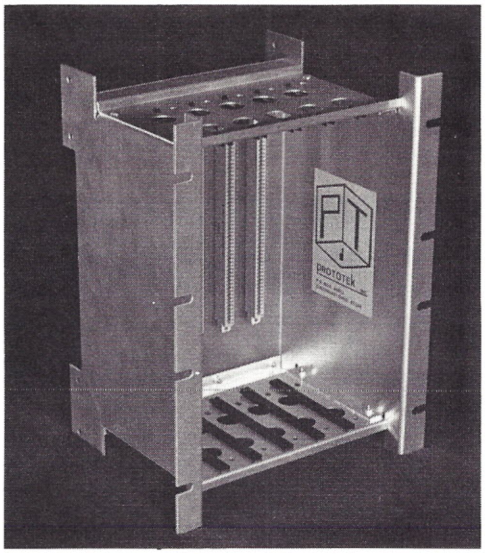
Six software packages, designed to run on SWTP 6800-based computers using either SWTP MF-68 or Percom LFD-400 disk systems and including full source code, have recently been released by Star-Kits, PO Box 209, Mt. Kisco NY 10549:

- Full-disk Sort-Merge—written in BASIC, can sort complicated files, as large as a full disk, in various ways. $35 on disk, $30 with listing only.
- BASIC Utility Package—renumbers BASIC programs, does pretty-printing automatically, reduces memory requirements, prints an index of all variables used and their locations, prints a table of all program transfers, helps keep track of program modifications. Disk price is $30.
- Interrupt-driven Terminal Driver—interfaces the main terminal or a serial printer to BASIC or machine-language programs so that both can run at the same time. Price is $20 on cassette, $25 on Percom disk.
- Checkbook-Balancing Package—does a complete balancing of a checkbook, keeps track of outstanding checks or deposits, maintains a year-to-date file, provides income tax summaries. Price is $40.
- Eliza—available in both BASIC and machine language. Doesn't require disk. Price is $15 on disk or cassette, $5 when combined with another purchase on same disk or cassette.
- Flogen—automatically flowcharts BASIC programs. Helps find subtle errors; useful for long-term documentation; requires 72-column printer. Free with any purchase. Reader Service number S120.

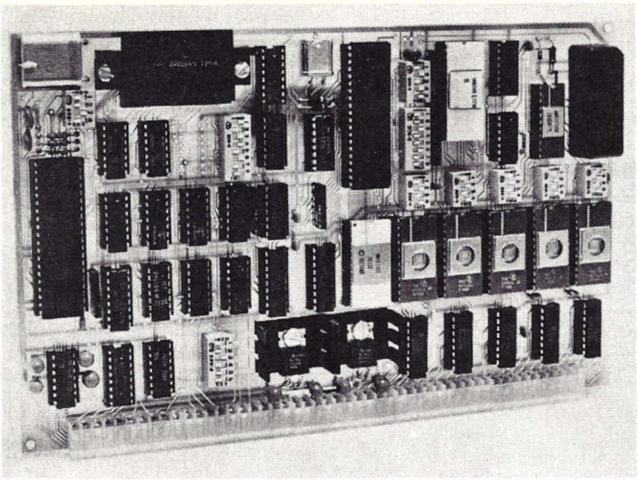
SSB's CPU Board

The 6800-based Super Computer Board (SCB-68) is designed for use as a dedicated microcontroller and business or single-board computer. It features 2


The H8 Extender Board.



Prototek card cage.



The SCB-68.

MHz operation, 1K of scratchpad RAM, a 2K EPROM monitor and can address 1 Mbyte of memory organized in sixteen 64K byte pages. It also provides space for up to 20K of EPROM. Optional features include a floating-point processor, RS-232 connector, real-time clock and serial I/O port with two controllable output lines and programmable baud rates to 56K baud.

A field programmable logic array (FPLA) controls the address decoding for the serial port, EPROM and floating-point processor, allowing customization by replacing the FPLA with another containing user code. Four option switches, used with the FPLA, are provided and can be user-defined within the array's code. Price is $249.95.

Smoke Signal Broadcasting, 31336 Via Colinas, Westlake Village CA 91361. Reader Service number S46.

I/O Card

The analog I/O 802 card consists of an eight-channel analog-to-digital converter and a two-channel latched D/A converter. Both A/D and D/A are eight bits with ±5 V full-scale analog inputs and outputs. Conversion time for the A/D is 2 milliseconds, and D/A settling time is 2 microseconds.

Packaged on a 4.25 × 3.75 inch PC card with socketed ICs, the unit is furnished with a 44-pin card edge connector. Power requirements are +12 V at 50 mA. On-board regulators supply signal reference. Input impedance of the A/D is greater than 10 megohms. The card is easily interfaced to two microcomputer I/O ports, including the I/O ports of the 6820, 6522, 6530, 3850, 3881, 8255 and 8212 ICs. Price is $115.

Optimal Technology, Inc., Blue Wood 127, Earlysville VA 22936. Reader Service number O10.

Educational Software

Three new educational software selections for the PET, Apple II and TRS-80 computers have been announced by Program Design, Inc., 11 Idar Court, Greenwich CT 06830:

Reading Comprehension: What's Different? for the PET computer builds analytical skills necessary for reading comprehension. The student must pick the one word in four which doesn't belong, for example, "red, blue, clear, green," where clear is not a color. Geared for second- to sixth-graders.

Minicrossword for Apple or TRS-80, builds vocabulary and spelling skills. The computer makes crossword puzzles from its word list and scores you on how well you do the puzzle. Suitable for all ages, including adults.

Work Skills 1—Prefixes for the PET, helps kids aged 10 and up improve their vocabulary and reading skills by presenting some common prefixes and the words they appear in. Reader Service number P61.

Solderless Prototype Board

CM-600, a unique system for solderless construction of circuit prototypes, is a neoprene board 4 1/2 inches (114 mm) × 6 inches (152 mm) with 2280 holes on .100 inch (2.54 mm) centers. Standard components, including DIPs, are mounted by simply inserting leads into the holes in the long-life neoprene material. Interconnections are easily made using 20 or 22 American Wire Gauge (AWG) wire jumpers. Positive contact is assured by the elasticity of the hole, which compresses the leads together.

To remove components or leads, simply pull out. This facilitates easy circuit changes making it ideal for breadboarding experimental circuits. CM-600 also features numbered rows and columns for easy reference. Accessory kit RW-50, containing 50 pieces of AWG 20 insulated jumper wires of assorted lengths, is $2.95 per kit; CM-600 is $6.95 each.

O.K. Machine and Tool Corp., 3455 Conner St., Bronx NY 10475. Reader Service number O5.

8080, Z-80 Business Software

Arkansas Systems, Inc., 8901 Kanis Rd., Suite 206, Little Rock AR 72205, has recently added the Order Entry and Inventory systems to its small-business systems software line of General Ledger, Payroll, Accounts Receivable and Accounts Payable. These six systems turn the 8080- or Z-80-based microcomputer hardware into turnkey business data-processing systems.

The systems are normally supplied to end users in object form and need no changes to be fully operational. Source code is provided to the distributor and can be purchased by the end user. No previous data-processing experience is necessary to operate the systems; each question is fully prompted, and overall descriptions are provided in the user's manual for each system. Reader Service number A113.

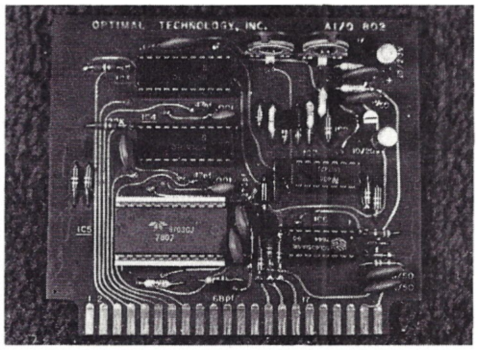
Rolltop Desk for Your Computer

A teakwood rolltop desk designed specifically for the TRS-80 and its peripherals (several other micros will also fit nicely: Apple, Compucolor, etc.) is now available from Personal Programming Service, Inc., 14600 Goldenwest St., Westminster CA 92683. The keyboard and expansion interface are hidden beneath a false drawer when not in use. A removable disk cabinet will accommodate up to four drives. Small drawers are just the right size for cassettes, and large drawers are printer-paper-sized. There is a legal-sized file drawer (with lock) located below a pull-out typewriter or work pedestal.

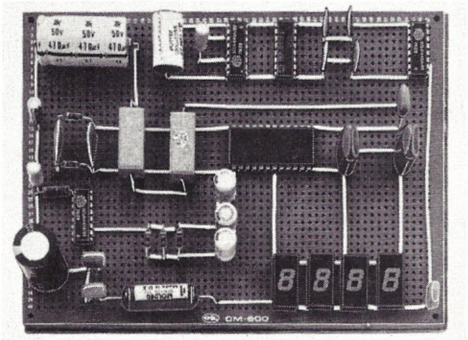
Designed for the home or business environment, the units are all hand-crafted teak available in numerous finishes. Matching chairs are also available. Reader Service number P81.

Tektronix Simulator

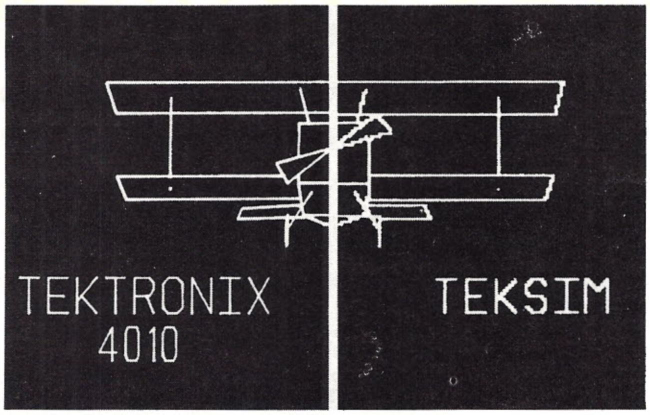
TEKSIM (Tektronix Simulator) is a ROM-based device that enables an Apple II computer to



The analog I/O 802 card.



The CM-600 Circuit Mount.



Typical TEKSIM image quality.

emulate Tektronix 4010-series graphics terminals. TEKSIM employs distributed processing in its programming approach and uses Apple's high-resolution plotting capabilities. No modification to the host-resident program is required to display or input graphical data.

Although the Apple has approximately one-fourth the resolution of the Tektronix terminal, a TEKSIM-Apple combination offers a substantial cost advantage, as well as exclusive features such as multi-colored displays, selectable erase and standard video output that lets any TV set be a monitor. Price is $795.

Cybersoft Systems, 301 S. Livernois, Rochester MI 48063. Reader Service number C163.

New Publications

TRS-80 Software Source Directory lists over 5000 TRS-80 programs alphabetically by title, BASIC, vendors, category and cassette/disk. The names of 380 vendors, with addresses and phone numbers, are included. Price is $6; foreign orders are charged an additional $2 for airmail. ComputerMat, Box 1664, Lake Havasu AZ 86403.

Programming the Z-80 by Rodnay Zaks may be used as a self-contained introductory text on programming or as a self-contained reference book. It offers a comprehensive description of the Z-80 instruction set and a thorough account of its internal operations and includes a chapter on data structures. The reader will learn to program, not just at the elementary level, but in most practical cases. Sybex, Inc., 2020 Milvia St., Berkeley CA 94704.

TARGET is a new bimonthly newsletter about Rockwell's AIM 65 System. Six issues cost $5. *TARGET*, c/o Don Clem, RR2, Spencerville OH 45887.

The *Medical Computer Journal*, a publication of the Doctors' Computer Club, lists information about the widespread use of computers in the daily practice of the private physician. Each issue focuses on ways in which the physician can use the computer to improve patient care and deals with such topics as common illnesses, computer systems, laboratory test interpretation and ideas for office improvement through the use of the computer. Subscriptions of $15 per year include a copy of the Dr. Computer's Report, the *Medical Computer Journal* newsletter. Dr. Aziz Ghaussy, editor, 42 E. High St., East Hampton CT 06424. Reader Service number C165.

LETTERS

(from page 17)

Clocks for Your Serial Interface" (October 1979), and would like to make a few comments on it.

According to my knowledge, the term baud refers to the maximum number of signal states (not transitions) possible per second on the given line. This is made a bit clearer by referring to synchronous communications systems involving phase modulation, such as the Bell 201B and especially the newer 201C modem.

The latter modem uses 12 different phase angles and two amplitude levels to represent four bits per signal period. Thus, the modem transmits over the phone lines at only 2400 baud; but since it transmits four bits in each combination of phase and amplitude, it sends at 9600 bits per second. Sending at 9600 baud over any kind of phone line Bell allows is impossible, but 2400 baud can be managed. Notice that asynchronous communications methods rarely employ anything other than the standard MARK/SPACE signaling, thus making baud and bps the same thing.

While on the subject of synchronous communication, I would like to mention that, though I have seen literature explaining this method (most notably John E. McNamara's excellent *Technical Aspects of Data Communications* from DEC), I have yet to see an article in any computer hobbyist magazine about using the universal synchronous receiver/transmitter (USRT) chips now available. These chips should prove very useful to hobbyists organizing large computer nets, as they allow much higher transmission rates over unconditioned phone lines (or maybe radio links, if the FCC allows eight-level codes someday) than do asynchronous modems. If I can dig up any information from some manufacturers about these ICs, I may even write the article if there is any interest in this area (and if someone better qualified doesn't beat me to it!).

Anyway, Derynck's was an interesting article and gave some useful information on the various bit generators available.

Lenny Foner
Belmont MA

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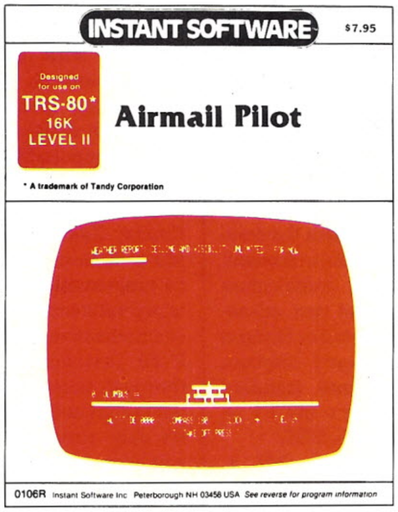

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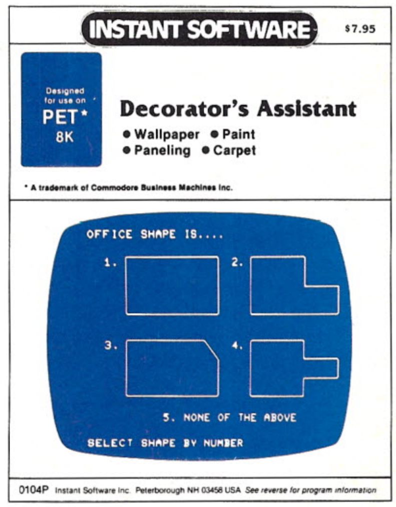

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William Stark
Design Engineer
Ithaca Intersystems

A Front Panel Computer for the S-100 Bus

This article traces the development of the new Ithaca Intersystems DPS-1 computer. The author discusses why the decision was made to build a computer with a front panel when the trend appears to be toward front-panelless computers. Examples are provided to demonstrate the usefulness of the front panel for on-site maintenance and software debugging.

The design goal for the Ithaca Intersystems DPS-1 was a modular computer users could configure to best meet their needs. As applications changed or became more complex, plug-in printed circuit boards could be installed, adding memory, peripherals or processors to the computer.

It was important that a user be able to construct a minimal system consisting of only an 8-bit CPU, memory and I/O that could, if desired, be expanded to a real-time minicomputer consisting of several 8- or 16-bit processors, up to 16 megabytes of memory and many sophisticated peripherals, including disks, analog I/O, communications and special-purpose modules, all supporting foreground/background data-base processing.

Background

The S-100 bus architecture was chosen to provide the customer access to a large number of plug-in modules. At the time the DPS-1 was being developed, the S-100 apparently was soon to become the most popular small-computer bus. Hundreds of peripherals and components, many of which were simply not available from other buses, were available on the S-100.

However, the S-100 had some serious limitations. The bus had originally been developed for the old Altair 8080 8-bit computer and was loosely specified. Incompatibility among various vendors' products was a problem. Sixteen-bit processors would not run on it, and the maximum address space was only 64K bytes. Worse, a common DMA protocol had never been agreed upon, which hindered plans for distributed and multiprocessing systems.

Fortunately, Bob Stewart was organizing an IEEE committee to establish international standards for computer buses; the S-100 bus was chosen as one of the first buses to be so specified. Kells Elmquist of Ithaca Intersystems, George Morrow of Thinker Toys, Howard Fullmer of Parasitic Engineering and representatives from other microcomputer manufacturers comprised the committee. Their work resulted in a redefined and extended S-100 bus. This bus maintains compatibility with most of the old designs.

The new standard allows up to 16 8- and/or 16-bit bus masters (CPUs or DMA devices) to share the bus; a fast arbitration scheme and a new DMA protocol permit the bus masters to transfer control smoothly without glitching; the address space has been increased to 16 Mbytes; all timing signals on the bus have been carefully defined to eliminate the compatibility problems between different manufacturers.[1]

Problems, Solutions, Goals

The one problem with providing all this versatility is that no two systems end up exactly the same, and frequently a system includes boards from more than one manufacturer. Sometimes this makes a system difficult to test.

Even with the drastic price reductions witnessed in computer hardware over the past few years, computers still cost a lot of money. Therefore, uptime is an important concern of any

The DPS-1 with the pop-off dress bezel on.

system architect.

A good repair strategy is to reduce the size of the problem by reducing the size of the system being tested. Since the motherboard itself contains few or no active components, it rarely breaks. It is therefore only necessary to determine which plug-in board or peripheral is responsible if a failure occurs.

When a board fails, it can be isolated by exchanging boards one at a time with known-good boards. The broken module can then be repaired or returned to the factory. Even if extra boards are not available, a faulty board can often be isolated by exercising functions that are unique to that board, or by testing the computer with the board in and out of the system.

A trivial example: if everything in a system works except for one channel of an analog-to-digital (A/D) converter board, it is safe to assume that the fault is in the A/D board. If the system doesn't work at all until the A/D board is removed, it is again likely that that board has failed.

However, if a fault occurs in a module that is required for even the basic operation of a system, then the failed component can be difficult to isolate.

Consider as an example a computer consisting of only a CPU; memory; input-output and disk interface board; one disk drive; a keyboard; and a printer.

All the programs, except the disk bootstrap in PROM, are on the disk. If the system fails to come "up," any of the listed components can be at fault. Without some kind of diagnostic hardware, it is almost impossible to isolate the fault because the system isn't complete if any of the components are removed. Because this kind of failure is the most common, Ithaca Intersystems decided that some type of diagnostic capability would be worthwhile. We set as a minimum requirement the ability to locate a failure to the board level. The board could then be swapped, repaired locally or returned to the factory.

Three types of diagnostic hardware were considered:

1. Firmware diagnostics consisting of programs stored in ROM (read-only memory). Programs that tested vital system components would be supplied, and if a fault was detected, an error message would be displayed at the terminal. This method is cheap and requires no special hardware—just a ROM socket somewhere in the computer.

2. A special bus master consisting of a DMA controller, a sequencer (maybe a CPU) and test programs stored in ROM. This piece of hardware would act as a go/no-go tester that would not depend on the bus or main CPU for its proper operation except for power. This method's greatest advantage is that it does not require any experience or knowledge on the part of the user.

3. A traditional front panel using LEDs to indicate the state of the data, address and status bits on the bus. We did not consider using hex digit displays because they obscured the meaning of individual signals, negating many of the advantages offered by a front panel.[2] Most designs are a mixture of functions, some that depend on the rest of the computer for proper operation and some that don't. The typical front panel functions are: Reset, Run/Stop, Examine, Examine Next, Deposit and Deposit Next.

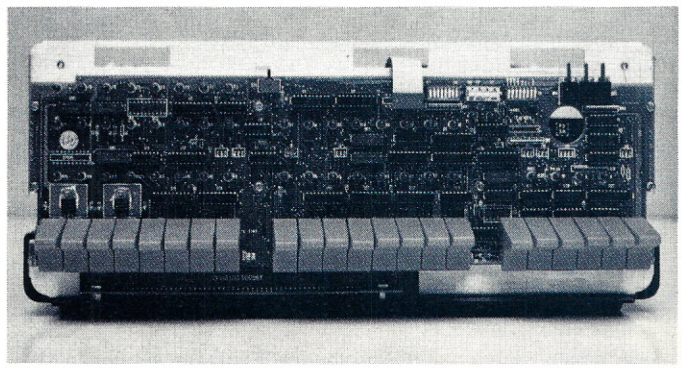
This type of front panel will sometimes directly identify the cause of an error, such as when it displays a data bit that is stuck high on a bus. Often, however, it will only indicate that a problem exists—for example, by failing to perform an Examine properly.

The disadvantage of this technique is that it requires the user or repair technicians to interpret the results of front panel tests. But for the same reason, it allows the greatest flexibility simply because new tests can be created for each type of fault. The traditional front panel's greatest advantage is that, if a user is somewhat skilled, the problem can be traced to the component level.

We eliminated the firmware diagnostics ROM from consideration almost immediately because it expected most of the system to be operating before it could do any good.

If a computer needs repair, the ROM probably won't work either because even small hardware faults usually cause the whole system to go down. This is not to say the approach itself is poor. A diagnostic ROM is a good complement to a system with additional debugging capabilities or complex I/O that is not part of the hardware kernel.

The choice between the special bus master and the traditional front panel was not so clear. However, the bus master was eliminated eventually for the following reasons.



The DPS-1 with the pop-off dress bezel removed. Note the extra switches, LEDs and test point that provide the additional function.

It would be as complex as the rest of the computer and would be as difficult to repair. It was important that any diagnostic hardware be as easy as possible to understand. For example, if the functions on the front panel were modular enough, the system could be bootstrapped up a piece at a time.

A front panel in the hands of a knowledgeable user is always more capable than a go/no-go tester. The bus master could be programmed to check out boards Ithaca Intersystems manufactured, but since every board required a test sequence, it would not be easy to support other vendors' boards in the system.

The traditional front panel can function as an instructional tool. It presents the computer at its most basic level and leads the user to a deeper understanding of the computer hardware.

By adding more functions, we could extend the concept of the traditional front panel, although earlier front panel designs had an incomplete complement of functions that would sometimes take the user only partway to a solution.

We also wanted to add functions that would aid development work done on the system. We thought that address and data breakpoints would be useful for both hardware and software development.

Unlike the special bus master, the usefulness of a front panel could be significantly increased by using it in conjunction with other readily available test equipment. Trigger and clock outputs could be provided to synchronize an oscilloscope or logic analyzer.

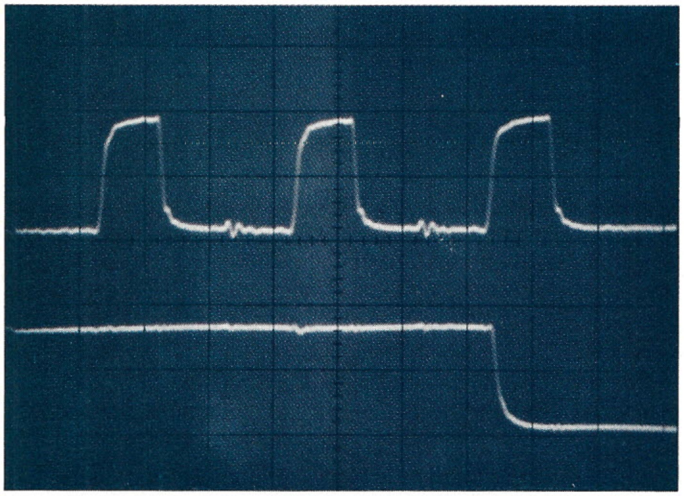
Furthermore, if any hardware development was to be performed on the system, the traditional front panel would clearly be the best choice.

Implementation

At first the goals for the new front panel seemed contradictory. Although many new functions were to be added so that a systematic method of repair could be developed, it was also important to keep the circuitry simple enough to understand. But adding functions would normally mean using more complex, and therefore harder to understand, integrated circuits. For a time it seemed unlikely that we could design in both the simple kernel and the new functions.

This conflict was resolved by structuring the circuitry into two levels, the first containing the traditional front panel functions

plus several new functions, the second containing "modifier" functions that operated on and modified the meaning of the first level. Many useful combination-functions thus resulted.



Scope photo of a normal Continuous Examine sequence. Top trace—three pSYNC pulses output by the processor board. Bottom trace—the XRDY signal output by the front panel. The processor stops when XRDY goes low. (500 ns/div.)

Front Panel Functions

- Run.
- Stop on M1.
- Run test point input (latched)—an external signal is latched and runs the computer.
- Stop test point input (latched)—an external signal is latched and stops the computer.
- Single Step—causes the processor to execute one cycle.
- Slow Step—causes the processor to single step at a variable repetition rate of 1/5 Hz to 1 kHz.
- Examine—causes the processor to jump to a specified address.
- Continuous Examine—causes the Examine sequence to occur at a 1 kHz repetition rate.
- Execute any 1-, 2- or 3-cycle sequence once.
- Execute any 1-, 2- or 3-cycle sequence at a 1 kHz repetition rate.
- Examine Next—increments the processor's program counter.
- Continuous Examine Next—causes the Examine Next sequence to occur at a 1 kHz repetition rate.
- Deposit—write into memory.
- Continuous Deposit—write into the same memory location at a 1 kHz repetition rate.
- Deposit Next—write into the next memory location.
- Continuous Deposit Next—write into a block of memory.
- Continuous NOP—forces the processor to execute NOPs at full speed.
- NOP Examine—NOP until an address match.
- Address Breakpoint—stop on address match.
- Address Breakpoint modified by status and external input.
- Latched Address Breakpoint.
- Data Breakpoint—stop on data match.
- Data Breakpoint with wait state.
- Data Breakpoint modified by status and external input.
- Latched Data Breakpoint.
- Not Data Breakpoint—run on data match.
- Not Data Breakpoint with wait states.
- Invert test points—uncommitted inverter.

Front Panel Outputs

- Bus Stable signal—indicates when the address and data buses are valid.
- Address Breakpoint signal—address match; may be modified by status and external input.
- Data Breakpoint signal—data match; may be modified by status and external input.
- Latched Breakpoint signal—latched data or Address Breakpoint signal.

These functions are intended to be used in a systematic manner to track down a fault in the computer circuitry or to develop new hardware or software. The Breakpoint and Bus Stable signals can be used to clock or trigger oscilloscopes, logic and state analyzers and signature analyzers.[3] The continuous functions can exercise the entire system in simple repetitive modes for analysis with the same test equipment. The use of these functions is best demonstrated by examples.

General Test Sequence. The following is the type of sequence that may be followed until a fault is found.

1. Check the simple things, such as power supplies, alignment of cards and connectors.

2. Remove extraneous boards from the computer; if the problem goes away, one of the removed boards is at fault. Reinstall cards until the system again fails, then remove the faulty card.

3. Observe the LED display while the computer is in a static state (during Reset, after Reset, after Stop). If an indicator is in the wrong state (as determined from a manufacturer-supplied table), it is usually easy to trace the faulty logic level back to a bad IC or a short.

4. Try the front panel functions in order of increasing complexity. If one of the functions fails, the corresponding continuous function can be used to create a stable display on an oscilloscope; then the timing can be compared to the diagram in the front panel manual.

5. Toggle into memory simple test programs. If they fail to run in the single-step mode, the instruction(s) executing improperly can be identified.

6. Check the more advanced system functions such as DMA or interrupts, which may have been exercised under step 5. Use the breakpoint functions to examine the operation of your application by either stopping the computer at a breakpoint or by triggering an oscilloscope.

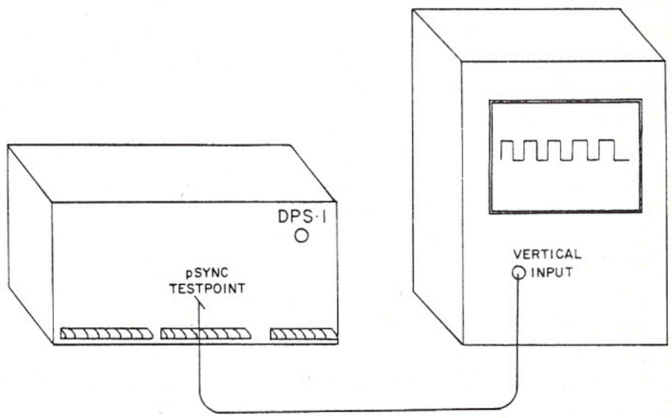


Fig. 1. Combining an oscilloscope and the DPS-1 to check computer timing.

This is an example of how the front panel can be used to fix a common failure. The user knows that the disk won't boot, and Examine won't work.

1. Read the section of the front panel manual that describes Examine.

2. Check the relevant bus signals. Everything seems to be OK, but you can't check the timing because Examine is a fast one-shot function that occurs too fast for display on a normal oscilloscope.

3. Using the Continuous Examine function, hook up your scope as shown in Fig. 1. This repeats the Examine function at the rate of about 1 kHz so that a stable display is presented for viewing.

4. You observe five pSYNC pulses on the oscilloscope, while the diagram in the manual

✓ Reader Service—see page 227

shows only three. The manual indicates that the processor is not being stopped at the right time.

5. The XRDY signal is used by the front panel to stop the processor. You check this signal and find that it is operating correctly.

6. You trace XRDY onto the processor card, where you find a gate with a 1 usec rise/fall time.

7. The Disk/Examine works after the gate is replaced. The disk failed because it used wait gates to synchronize its data transfers.

The operating system keeps crashing. You suspect faulty memory. You want to run a memory test, but it's on a disk so it can't be loaded.

1. Use the Continuous Deposit Next function to load a test pattern into the block of memory used by the operating system.

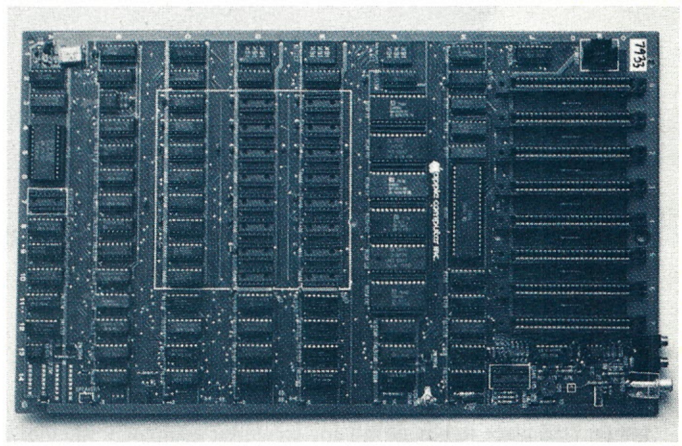
2. Set the front panel for a Not Data Breakpoint. Run through the block. The front panel compares the data you just loaded into the block with the pattern set into the switches. If you didn't change the switches, the pattern is the same. If any byte is wrong, the computer will stop, displaying the address and bit location of the bad memory on the indicator LEDs.

The software that sets up a DMA device causes it to write to the wrong address. This crashes the system. A software breakpoint can't be used because the CPU is shut down during a DMA.

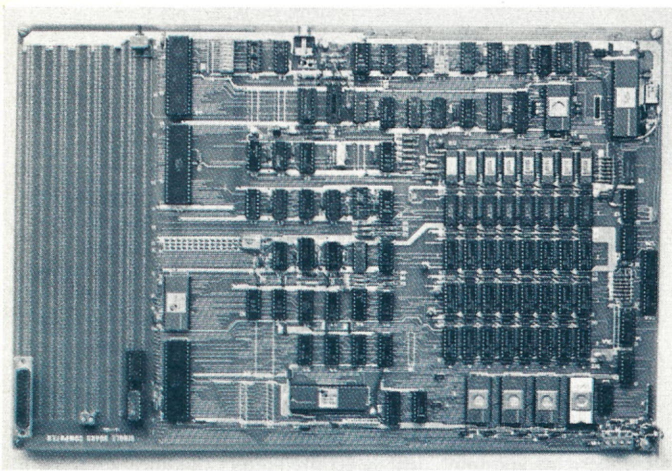
1. The front panel's hardware breakpoint is used to stop the computer during the DMA.

2. The wrong jump location is found.

There are several classes of microcomputers on the market today. These groupings vary mainly in how the circuitry of the computer is divided. A single-board microcomputer is built with all of the necessary components—microprocessor, memory and I/O—placed on a single printed circuit board. At the other end of the spectrum, the circuitry for a bus-structured computer is distributed on separate circuit boards that are interconnected by a bus. Finally, the hybrid approach places some of the circuitry (CPU, memory, video out, keyboard in) on one board, and a short expansion bus is provided.



The Apple, an expansion bus computer, combines features of single-board and bus-structured computers. The basic computer contains a 6502 processor, CRT controller, parallel I/O and memory expandable to 48K.



A single-board computer, the Intersystems IA-1120, contains 68K RAM, 4 ROM sockets, 4 MHz Z-80, CRT controller, parallel and serial I/O, a counter-timer and a wire-wrap area for custom circuitry. The next version will include a floppy-disk controller.

The Best Design?

For a small system, the single-board design will always be the least expensive because there are few or no connectors, no bus driver circuitry is normally needed and the power supplies and case can be smaller. While it is easy to provide extra sockets for some memory expansion, and peripherals such as disk controllers can be added, as the system becomes larger it becomes less cost effective. Since the computer is available in only a limited number of configurations, it is easier for a service center to repair than a bus-structured system. Technicians can learn to fully understand the one board, and it is practical to invest in costly automatic test equipment.

Because a bus-structured computer can be designed using more printed circuit board area, a larger, more capable, computer can be assembled. Another advantage is that the user is not limited to a single configuration but can select from a large number of pluggable functions to assemble a system that matches his needs. Better still, as technology advances or needs change, it is easy and cost effective to upgrade a bus-structured computer. For example, since all Ithaca Intersystems S-100 memory and peripheral boards are compatible with existing 8-bit, as well as the new 16-bit, processors, it is simple to exchange a Z-8000 CPU card for an older 8-bit board.

The expansion-bus computer is a hybrid. It offers some of the flexibility of the bus-structured computer with some of the cost savings of the single board; but this flexibility is limited. For example, it isn't possible to change the structure of the computer by adding or exchanging CPUs or reconfiguring memory data paths.

Therefore, when a problem is best solved by a fairly standard architecture—CPU, less than 64K memory, standard I/O, floppy disks—and low cost is more important than performance—a single-board or expansion-bus computer is often the best choice. However, if the task to be performed requires a larger machine, the original purchase price of the single board approaches that of the bus-structured machine, and factors such as expandability, the cost of downtime and the cost of repair are of greater concern to the user. Especially where quick on-site repair is required, a front-panelled, bus-structured computer is the appropriate choice.

While a bus-structured computer isn't the solution for all problems, its ability to be upgraded and modified prolongs the useful lifetime of the entire system, and thus often makes it the most economical choice. ■

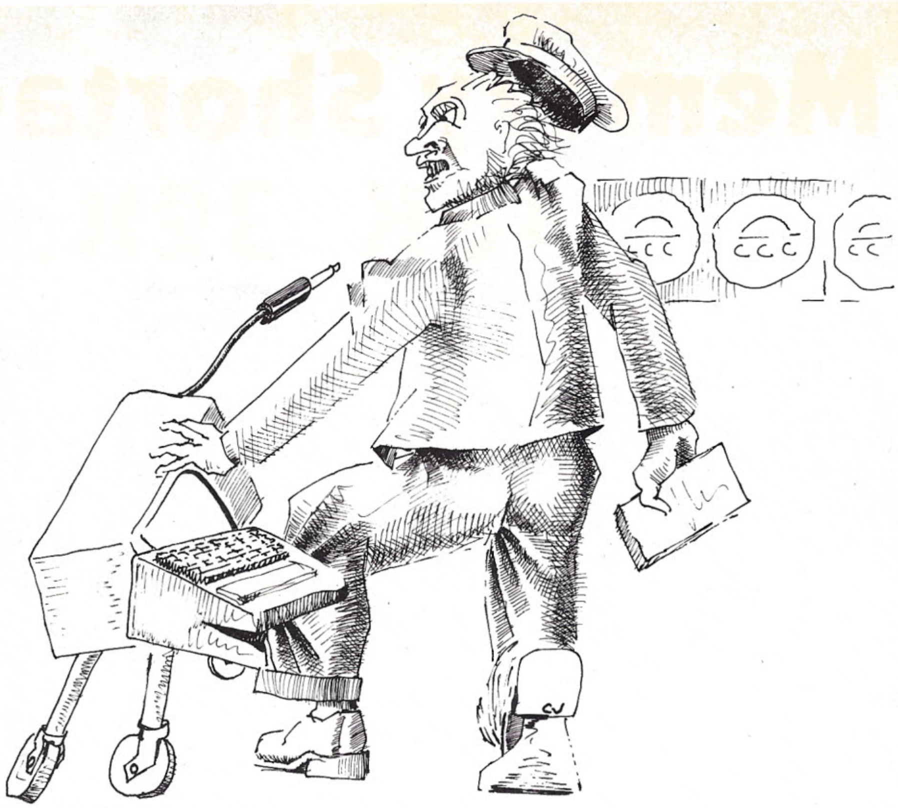
References

1. Bob Bosen, "Troubleshooting Tips and Techniques," *Kilobaud Microcomputing,* July 1979, p. 84.

2. K.A. Elmquist, et al., "Standard Specification for S-100 Bus Interface Devices," *Computer,* July 1979, p. 28.

3. "Application Note 222—A Designer's Guide to Signature Analysis," Hewlett-Packard.

Electric Bill Watchdog



If you're going to freeze this winter because you can't afford to subsidize the Arabs and the oil companies, at least be able to see the onset of the first stages of hypothermia.

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In this day of rising fuel costs, the conservation bug has bit us where it counts—in the pocketbook. After trying to figure out why, with the thermostat at 66 and the lights off (except for our CRT giving us enough light to punch keys by), our electric bill didn't drop enough, so we decided to write a program to tell us what to expect to pay each month in tribute to our local electric company.

This program, which will easily run in TRS-80 Level I 4K BASIC, may not lower your bill

```
THIS PROGRAM WILL FIGURE YOUR ELECTRIC BILL FOR YOU
AND HELP YOU CONSERVE ENERGY BY FORCASTING
YOUR NEXT BILL AS WELL AS YOUR YEARLY COST BASED ON
YOUR CURRENT RATE OF CONSUMPTION..................

WE WILL NEED A FEW BITS OF INFORMATION FROM YOU TO
GET STARTED-----GRAB LAST MONTH'S BILL AND LET'S GET
DOWN TO BUSINESS !!

      PRESS -----------ENTER ---------TO CONTINUE

              (CLEARS THE SCREEN)

WHAT WAS THE ENDING READING ON YOUR LAST BILL ?1250

WHAT IS THE PRESENT READING ? 2250

              (CLEARS THE SCREEN)

WE WILL NOW ENTER THE RATE SCALE FOR YOUR ELECTRIC COMPANY
ENTER THE INFORMATION ASKED FOR IN THE FOLLOWING FORMAT
COST FOR THE FIRST (XXX) KWH IS (YYY) CENTS PER KWH

EX...COST FOR THE FIRST 100 KWH IS 8.3344 CENTS PER KWH

COST FOR FIRST? 100   KWH IS? 7.4986    CENTS PER KWH
COST FOR NEXT?  400   KWH IS? 6.7893    CENTS PER KWH
COST FOR NEXT? etc....
COST FOR NEXT? etc....
"ANY MORE INCREMENTS....YES=1, NO=Ø? 1
COST FOR NEXT? etc....
 ANY MORE INCREMENTS....YES=1, NO=Ø? Ø

              (clears the screen)

WHAT DAY OF THE BILLING CYCLE IS THIS? 15

HOW ARE YOU BILLED?? 1=MONTHLY, 2=BIMONTHLY ? 1

WHAT IS TODAY'S DATE? 25 DEC 78

WHAT IS MINIMUM MONTHLY CHARGE? 4.65

WHAT IS THE SURCHARGE(IN PERCENT)? 8.47

WHAT IS THE FUEL ADJUSTMENT CHARGE (IN CENTS)? .000119

(if you had entered zeroes or the same reading for beginning
 reading and ending reading, you would get the following....)

IF YOU KEEP THIS UP, YOUR NEXT BILL WILL ONLY
BE THE MINIMUM MONTHLY CHARGE OF $4.65
WANNA TRADE ELECTRIC BILLS???
THANK YOU.....CALL ON ME AGAIN SOMETIME

(if you did enter valid readings, you would get the following
 display......the figures used in this illustration are numbers
 off the top of my head and do not represent the accuracy of
 the program....)
                        ENERGY REPORT

DATE.......................................25 DEC 78
KWH USED TO DATE ..........................1000
AVERAGE USAGE PER DAY......................66.66
COST PER DAY...............................$ .63
COST TO DATE...............................$11.25

   **** PROJECTED STATUS AT END OF BILLING CYCLE ****

KWH USED...................................2000
YOUR NEXT BILL WILL BE.....................$18.66
YOUR ANNUAL FUEL COST. BASED ON THE ABOVE
CONSUMPTION RATE WILL BE...................$215.75

THANK YOU.....CALL ON ME AGAIN SOMETIME
```

Sample run.

for you, but it will take the shock out of opening that official envelope with the "DO NOT SPINDLE OR MUTILATE" card inside—and it may even help you determine if it really is necessary to wear mittens at the keyboard.

All you need is your last month's electric bill, your electric company's rate scale (call them if they don't provide the rates on the back of your bill) and the nerve to go out and read your meter. Armed with these facts, you are ready to become a watchdog of your electric consumption as well as the power company's billing computer. Who knows, your micro just may find an error made by their "big boy."

The Program

Basically the program works like this: The beginning reading is subtracted from the ending reading to determine the amount of energy used thus far. Using the rate scales you entered, the program checks and subdivides the amount into the proper increments for computation to yield current costs and costs per day up to this point.

Next, the program projects your usage to the end of your billing cycle based on the above consumption and recomputes the cost for your billing cycle. Additionally, the cost for the entire year is projected in the same manner. The rate scales have been made variable to accommodate any geographical area or power company. (You can call your brother in Guam and tell him what his next electric bill will be . . . call him collect, I haven't finished the Telephone Bill program yet!) Individual users may wish to rewrite this section of the program to make the rates constant for their particular needs; but be careful—most companies' rates change with the season. If this is true of your power company, leave the rates as variables.

The program can be used for several purposes, such as planning next month's bills, figuring yearly usage and seasonal fluctuations, etc. Or you might want to try this: take a meter reading, then another in about five or six days. Now, turn off or cut down on the use of some appliance and take another reading in about five or six more days. Run the program with both sets of readings and see how much that appliance changed your average daily cost. By doing this with several different appliances in your house, you can determine which appliance is costing you the most money to run and where you can save the most by limiting the use of those fuel hogs.

After you have determined what your bill is going to be at the end of this month, don't have the electric company shut off all of your power—we know, oil lanterns and wood stoves are quaint, and romantic too, but your micro does need just a little bit of power. Perhaps you can, however, cut back a little on *something* (convince someone that the dishwasher is less useful than your computer), and next month, when you run this program, you might be happily surprised. ■

```
90 CLS
100 P."THIS PROGRAM WILL FIGURE YOUR ELECTRIC BILL FOR"
101 P."YOU, AND HELP YOU CONSERVE ENERGY BY FORCASTING"
102 P."YOUR NEXT BILL AS WELL AS YOUR YEARLY COST BASED ON"
103 P."YOUR CURRENT RATE OF CONSUMPTION................."
104 P.:P.:P.
105 P."WE WILL NEED A FEW BITS OF INFORMATION FROM YOU TO"
106 P,"GET STARTED----GRAB LAST MONTH'S BILL AND LET'S GET"
107 P."DOWN TO BUSINESS !!"
108 P.:P.
109 IN. "PRESS ---------- ENTER --------- TO CONTINUE";B$
110 CLS
120 INPUT "WHAT WAS THE ENDING READING ON YOUR LAST BILL";Q
130 P.:P.:P.
140 INPUT "WHAT IS THE PRESENT READING";P
141 CLS
142 P."WE WILL NOW ENTER THE RATE SCALE FOR YOUR ELECTRIC COMPANY"
143 P."ENTER THE INFORMATION ASKED FOR IN THE FOLLOWING FORMAT"
144 P.:P."COST FOR THE FIRST (XXX) KWH IS (YYY) CENTS PER KWH"
145 P.:P."EX,...COST FOR THE FIRST 100 KWH IS 8.3344 CENTS PER KWH"
146 P.AT448,"COST OF FIRST" :P.AT463;:IN.A:P.AT469,"KWH IS"
147 P.AT476;:IN.B:P.AT485,"CENTS PER KWH"
148 P.AT512,"COST FOR NEXT":P.AT527;:IN.C:P.AT533,"KWH IS"
149 P.AT540;:IN.D:P.AT549,"CENTS PER KWH"
150 P.AT576,"COST FOR NEXT":P.AT591;:IN.E:P.AT597,"KWH IS"
151 P.AT604;:IN.F:P.AT613,"CENTS PER KWH"
152 P.AT640,"COST FOR NEXT":P.AT655;:IN.G:P.AT661,"KWH IS"
153 P.AT668;:IN.H:P.AT677,"CENTS PER KWH"
155 IN."ANY MORE INCREMENTS.....YES=1, NO=0";N
156 IF N=0 GOTO 180
157 P.AT704,"COST FOR NEXT":P.AT719;:IN.I:P.AT725,"KWH IS"
158 P.AT732;:IN.J:P.AT741,"CENTS PER KWH"
159 IN."ANY MORE INCREMENTS........YES=1,NO=0" ;N
160 IF N=0 GOTO 180
161 P.AT768,"COST FOR NEXT":P.AT783;:IN.X:P.AT789,"KWH IS"
162 P.AT796;:IN.Y:P.AT805,"CENTS PER KWH"
180 CLS:J=H:Y=H:I=999999:X=999999
181 IN."WHAT DAY OF THE BILLING CYCLE IS THIS";S
182 R=P-Q
183 U=R/S
185 IN."HOW ARE YOU BILLED?? 1=MONTHLY, 2=BIMONTHLY";Z
186 O=30*Z
187 IN."WHAT IS TODAY'S DATE";A$
188 IN."WHAT IS THE MINIMUM MONTHLY CHARGE";K
189 IN."WHAT IS THE SURCHARGE(IN PERCENT)";L
190 B=B/100
191 IN."WHAT IS THE FUEL ADJUSTMENT CHARGE(IN CENTS)";M
192 M=R*M
193 L=L/100
200 D=D/100
210 F=F/100
220 H=H/100
225 J=J/100
240 Y=Y/100
360 IF R<>Ø GOTO 400
370 P.:P."IF YOU KEEP THIS UP, YOUR NEXT BILL WILL ONLY"
380 P."BE THE MINIMUM MONTHLY CHARGE OF $";K
390 P."WANNA TRADE ELECTRIC BILLS???"
395 GOTO 460
400 U=R/S
402 V=R
405 T=U*O
406 W=S
407 GOSUB 20030
410 W=P/W
420 P."                ENERGY REPORT              "
421 P."DATE....................................";A$
422 P."KWH USED TO DATE.........................";V
423 P."AVERAGE USAGE PER DAY...................";U
424 P."COST PER DAY............................$";W
425 P."COST TO DATE............................$";P
430 P.
431 P." **** PROJECTED STATUS AT END OF BILLING PERIOD ****"
437 R=T
438 GOSUB 20030
440 V=P*12/Z
441 P."KWH USED.................................";T
442 P."YOUR NEXT BILL WILL BE..................$";P
443 P."YOUR ANNUAL FUEL COST BASED ON THE ABOVE"
444 P."CONSUMPTION RATE WILL BE ---------------$";V
460 P."THANK YOU.....CALL ON ME AGAIN SOMETIME"
470 END
20030 K=Ø:O=Ø:Q=Ø:S=Ø:N=Ø:X=Ø:P=Ø
20032 IF R>A GOTO 20040
20035 K=R*B: GOTO 25000
20040 R=R-A: K=A*B
20050 IF R>C GOTO 20060
20052 IF R=Ø GOTO 25000
20055 O=R*D: GOTO 25000
20060 R=R-C : O=C*D
20062 IF R>E GOTO 20070
20064 IF R=Ø GOTO 25000
20066 Q=R*F: GOTO 25000
20070 R=R-E: Q=E*F
20072 IF R>G GOTO 20080
20074 IF R=Ø GOTO 25000
20076 S=R*H: GOTO 25000
20080 R=R-G: S=G*H
20082 IF R>I GOTO 20090
20084 IF R=Ø GOTO 25000
20086 N=R*J: GOTO 25000
20090 R=R-I: N=I*J
20092 IF R=Ø GOTO 25000
20094 X=R*Y
25000 P=K+O+Q+S+N+X
25010 P=(P*L)+P
25020 P=P+M
25030 RETURN
```

Program listing.

Don Lancaster
Synergetics

Lowercase for Your Apple II (Part II)

The first part of this article introduced an inexpensive hardware mod to transform the Apple II into an uppercase/lowercase machine. Now for the software to complete the mod.

In part 1, we introduced a low-cost hardware modification to turn your Apple II into a combined uppercase/lowercase computer. In part 2 of this article, we will examine the software needed to complete the modification.

How much software you need depends on what you want to do with your new lowercase ability. If you are only going to use it to annotate an occasional game, very little new software will be needed. Most likely, your lowercase software will have to interact with any floppy disks or printers you have on-line, and you'll want an extensive editing capability. So, let's look at three different levels of software involvement.

First, we'll use the absolute minimum to display lowercase on the screen. Then, we'll show you software that lets you fill the screen with mixed uppercase and lowercase, with a working carriage return, scroll and so on. Finally, we'll check into a "heavyweight" full lowercase editing program that lets you put any character you want anywhere on the screen without the prompts and with full and easy editing. From here on, you'll be on your own to interact with what you really want to do with your new lowercase ability.

Lowercase

32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
\	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
p	q	r	s	t	u	v	w	x	y	z	<	¦	>	~	■

Uppercase

128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	↑	—

Numerals

160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
spc	!	"	#	$	%	&	'	(	)	*	+	,	–	.	/
176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?

Fig. 1. Decimal character codes needed for direct POKEing into display memory. Use software only to flash lowercase. To flash uppercase or numerals, subtract 64 from the decimal value or use software. Decimal numbers now shown are redundant.

We will use integer BASIC for our software. This is easy but risky. Cursor and entry programs are fast and efficient when written in machine language. Integer BASIC *may* end up too slow for some things, particularly for repeatedly inserting and deleting characters. But integer BASIC is flexible and easy to use. It's also easy to change. So, we'll use the integer BASIC route. If things turn out a bit slow, we can pull some of the stunts in the green Apple book to speed things up. Once you know exactly what you want, you can go the machine-language route.

We will note in passing that there are simple and elegant machine-language cursor and entry manipulations already in the Apple monitor. These are available for call to an integer BASIC program. But, many of these sequences *demand* uppercase only and are restrictive in how you access them. So, we will avoid using what is already on hand—unless these sequences clearly and simply speed things up for us without creating more hassles than they solve.

Direct Entry

The minimum software route for displaying lowercase is to simply POKE the value of the character into the place you want it to go on the screen. This is very limited if you want to put down more than a few characters at once.

We'll shortly see what the decimal memory locations of every point on the display are. For instance, we'll find out that the bottom line of the screen goes from decimal 2000 at the left to decimal 2039 at the right.

Fig. 1 shows you the correct character codes for all the characters *as they are to be stored in memory.* For instance, say you want to put a character on the bottom line, third from the left. For an uppercase A, use POKE 2002,129. For a lowercase a, use POKE 2002, 33, and so one.

The missing numbers in Fig. 1 are repeats of the characters already shown. A POKE in the range of 64 to 127 will flash an uppercase character or letter. I haven't found a good hardware way to flash lowercase, so we will use software for flashing or winking cursors. More on this later.

A. To read the keyboard:

```
200 CHAR = PEEK( - 16384): IF CHAR<127 THEN 200: POKE ( - 16368),0
```

This sequence stays at 200 till a key is pressed. Key value before strobe reset appears as CHAR.

B. To print the decimal value of a pressed key:

```
200 CHAR = PEEK( - 16384): IF CHAR<127 THEN 200: POKE ( - 16368),0 :
    PRINT CHAR : GOTO 200
```

This sequence stays at 200 till a key is pressed. Key decimal value is displayed for each new key pressed. CTRL C stops the action.

C. To stop a program without scrolling or prompting:

```
600 GOTO 600
```

This trap holds the screen and prevents scrolling or prompting. To get out of the trap, use CTRL C.

D. To measure the speed of an integer BASIC sequence:

```
100 FOR N = 1 TO 10000
200 (((((SEQUENCE GOES HERE)))))
300 NEXT N
```

The execution time in *milliseconds* equals *one-tenth* the number of *seconds* from RUN till the speaker beeps, minus the time (about 1 millisecond) to run without step 200.

Fig. 2. Apple II integer BASIC utility sequences.

Four Utility Sequences

It's far more desirable to get your characters from the keyboard than extracting them from memory or using POKE commands. Before we look at the lowercase keyboard entry data, let's pick up some integer BASIC utility sequences that may be very handy for us. Four of these sequences are shown in Fig. 2.

First and most important, we have to be able to read the keyboard without using a carriage return for every character. Fig. 2a shows us how to do this. The Apple II keyboard is located at decimal −16384. If a key is pressed, the number at this location will exceed decimal 127, and the value will correspond to the selected key.

We'll call the look at the keyboard CHAR, short for character. We'll keep looking at the keyboard with the PEEK command. A CHAR that is more than 127 means a key has been pressed, so we save the value of CHAR. Then we reset the keyboard strobe with the POKE (−16368),0 command shown. Be sure to always reset the keyboard after you read it. Your value for CHAR is the decimal equivalent of the pressed key. It can be used in the next step of your program or saved till needed. After you are done with this particular key, jump to 200 to await a new closure.

You can print the decimal values of all the keys simply by adding a PRINT CHAR command. This will display the value of each key as it is pressed (see Fig. 2b). The results of this for all the keys are shown in Fig. 3. You'll find this chart convenient to decode the various control functions. We see that the Apple II keyboard has no apparent way to provide lowercase characters, as well as the uppercase \ and [. Control characters NUL, FS, GS, RS and US are also not immediately available. Uppercase] is hidden as a shifted M and is used as the AppleSoft prompt.

One of the more infuriating things that happens when you are building a display editing program is that you put something somewhere, and then the BASIC throws in a scroll and a prompt, moving everything up the screen. To temporarily defeat the return to BASIC, just use a trap such as the 600 GOTO 600 shown in Fig. 2c. Your program will stick in the trap till you release it. This allows you to watch part of a program to make sure it is doing what you want it to. To release your trap, use CTRL C. You must, of course, eliminate all traps from your final program.

Suppose something we do turns out too slow. How can we find out how fast our BASIC is working for us? Fig. 2d shows us the way to measure the execution time of any BASIC sequence. What you do is repeat the sequence over and over again for 10,000 times in a loop. The number of *tens* of seconds it takes to execute the sequence will equal the number of milliseconds the sequence actually took. This is easily timed with a kitchen clock or a stopwatch. Be sure to subtract the millisecond it takes for the timer loop to cycle with nothing inside the loop.

With luck, you will never need this speed measurer. But, if ever you have characters being ignored or have things taking far too long in your particular program, this how-fast-is-it program can often show you what is holding up the works.

A Lowercase Tester

Program A shows us a simple program that reads the keyboard and puts lowercase characters on the bottom line of the display for us. The program has only one feature—it is short. This makes it convenient for initial tests. But since it lacks a cursor and a way to print uppercase and prints all machine commands on the screen, we'll really need a better program for anything but checkout.

The program is a simple loop that progresses across the bottom line addresses 2000 to 2039. We read the keyboard in 110, until a key is pressed. Then we reset the keyboard. If the character has a value greater than decimal 192, we subtract 160 from it to convert it to lowercase. For instance, an uppercase A will have a CHAR value of 193, per Fig. 3. Subtract 160 from this to get 33, the lowercase a needed in Fig. 2. We then load the character onto the display in the cursed position. Incrementing the loop with the NEXT CURS instruction in 150 moves us across the screen while the GOTO 100 in line 160 resets us to the beginning of the line.

A Useful Display Program

Let's add some statements to Program A to make it more useful. We can scroll at the end

NORMAL		SHIFT		CTRL	
1	(177)	!	(161)	1	(177)
2	(178)	"	(162)	2	(178)
3	(179)	#	(163)	3	(179)
4	(180)	$	(164)	4	(180)
5	(181)	%	(165)	5	(181)
6	(182)	&	(166)	6	(182)
7	(183)	'	(167)	7	(183)
8	(184)	(	(168)	8	(184)
9	(185)	)	(169)	9	(185)
0	(176)	0	(176)	0	(176)
:	(186)	*	(170)	:	(186)
–	(173)	=	(189)	–	(173)
ESC	(155)	ESC	(155)	ESC	(155)
Q	(209)	Q	(209)	DC1	(145)
W	(215)	W	(215)	ETB	(151)
E	(197)	E	(197)	ENQ	(133)
R	(21)	R	(210)	DC2	(146)
T	(212)	T	(212)	DC4	(148)
Y	(217)	Y	(217)	EM	(153)
U	(213)	U	(213)	NAK	(149)
I	(201)	I	(201)	HT	(137)
O	(207)	O	(207)	SI	(143)
P	(208)	@	(192)	DLE	(144)
RETURN	(141)	CR	(141)	CR	(141)

NORMAL		SHIFT		CTRL	
A	(193)	A	(193)	SOH	(129)
S	(211)	S	(211)	DC3	(147)
D	(196)	D	(196)	EOT	(132)
F	(198)	F	(198)	ACK	(134)
G	(199)	G	(199)	BEL	(135)
H	(200)	H	(200)	BS	(136)
J	(202)	J	(202)	LF	(138)
K	(203)	K	(203)	VT	(139)
L	(204)	L	(204)	FF	(140)
'	(187)	+	(171)	;	(187)
←	(136)	BS	(136)	BS	(136)
→	(149)	NAK	(149)	NAK	(149)
Z	(218)	Z	(218)	SUB	(154)
X	(216)	X	(216)	CAN	(152)
C	(195)	C	(195)	ETX	(131)
V	(214)	V	(214)	SYN	(150)
B	(194)	B	(194)	STX	(130
N	(206)	↑	(222)	SO	(142)
M	(205)	]	(221)	CR	(141)
,	(172)	<	(188)	,	(172)
.	(174)	>	(190)	.	(174)
/	(175)	?	(191)	/	(191)
SPACE	(160)	SPACE	(160)	SPACE	(160)

Fig. 3. Decimal codes for the Apple II keyboard. REPEAT, SHIFT and CTRL act only on other keys. RESET is direct acting. Bordered values = control commands. Values shown are before strobe reset. For ASCII equivalent, subtract decimal 128.

of the line to move the statements progressively up on the display. We can decode a RETURN to do the same thing. And, if we can only figure out some way to get both uppercase and lowercase characters out of an uppercase keyboard, we will be home free toward a simple way to get continuous uppercase and lowercase messages displayed.

To trick the keyboard into being something it is not, we'll use the ESCAPE key. We'll set the program up so that under "normal" conditions you get all lowercase characters. If you hit ESCAPE once, only the next character will be capitalized. This is just like hitting SHIFT momentarily on a regular typewriter.

If you hit ESCAPE twice in a row, the keyboard will lock into an uppercase-only mode. This is just like using the LOCK on a regular typewriter. If you are locked into uppercase, hitting ESCAPE one more time gets you into lowercase once again, just as hitting SHIFT after LOCK on a typewriter puts you back into lowercase. However, since we are using software, our ESCAPE commands will only apply to the alphabet—everything else stays the same.

This may sound complicated, but it's simple to use. When and if your Apple II is to have mixed uppercase and lowercase, just use ESCAPE instead of SHIFT to shift the alphabet. Everything else stays the same.

The software behind this is simple enough. We have a variable called SHIFT and a variable called LOCK. Every time a character is entered, it attempts to reset SHIFT to zero and is allowed to do so if LOCK is also a zero.

When an ESCAPE key is sensed:

1. First you check to see if LOCK is a 1. If so, this means you want to *release* all caps, so you simply make LOCK a 0 and SHIFT a 0 and go on to the next key.

2. Then you check to see if the previous key is also an ESCAPE. If it is, SHIFT must be a 1, since no intervening character has a chance to reset SHIFT back to 0. We then make LOCK a 1 and go on to the next key.

3. If you got this far, SHIFT and LOCK must both be 0. This means you either want to capitalize only one word, or else another ESCAPE will follow to lock. So, make SHIFT a 1 and then go on to the next key.

```
100 FOR CURS = 2000 TO 2039
110     CHAR = PEEK ( - 16384): IF CHAR<127 THEN 110
120     POKE ( - 16368),0
130     IF CHAR>192 THEN CHAR = CHAR - 160
140     POKE CURS,CHAR
150     NEXT CURS
160 GOTO 100
```

Program A. Lowercase test program. Puts lowercase characters on the bottom display line. Numerals and punctuation appear normally. Use this program only for hardware checkout. CTRL-C restores normal BASIC operation.

The new, improved program is shown in Program B. This enters full alphabet characters sequentially on the bottom line for us, with working scroll and carriage return. SHIFT is used for everything already on the keycaps, while ESCAPE is used to pick upper, lower and mixed cases. Once again, one ESCAPE capitalizes only the next character. Two ESCAPEs capitalize everything, until a third ESCAPE resets back to lowercase.

The program works the same way as Program A does. Line 100 indexes us across the bottom of the screen, while 110 reads the keyboard for us.

Line 120 tests for carriage return and calls for a scroll if one is needed. Line 130 tests for ESCAPE and then does the shift lock processing in lines 190-210. If shift is not locked,

line 140 converts to lowercase. Line 150 enters the characters on the screen.

Your turn: What does line 160 do in Program B ? Why is it needed.

Line 170 tells us to pick the next character location to the right. If this happens to be off the screen to the right, we drop out of the loop, do a scroll and start over.

A Full-Performance Lowercase Editor

The previous "gee-whiz" programs are handy to put lowercase on an Apple II. But, what we really may want is some full editing system that lets us:

- Put any character anywhere on the screen.
- Move around anywhere we like.
- Insert and delete characters and lines.
- Justify, ragged or flush right.
- Have lines longer than 40 characters.
- Transfer into and out of floppy.
- Provide hard-copy output.
- Have an attractive cursor for all characters.
- Have no BASIC prompts or unwanted scrolls messing up the screen.

Let's look at some of the bits and pieces that will be helpful to build an editor and display system. Then we'll show you a medium-complexity display editor that lets you wander around the screen with a vengeance. From there, you should be able to pick up just about as fancy a text editor as you care to.

Apple Display Memory Locations

The Apple people were among the first to recognize the incredible power and economy of using main memory also as a display memory. They do this by sharing each clock cycle so that the computer gets the memory for half a microsecond and the dedicated system timing gets the memory for display uses on the other half.

As you find out fast when you try to stuff things onto the screen, the memory locations are *not* sequential and are not all in one piece. How can we find what goes where?

The Apple II has two display pages, one residing between decimal 1024 and 2047 and a second page immediately above. Only the first page is normally used. Fig. 4 shows us a hex map

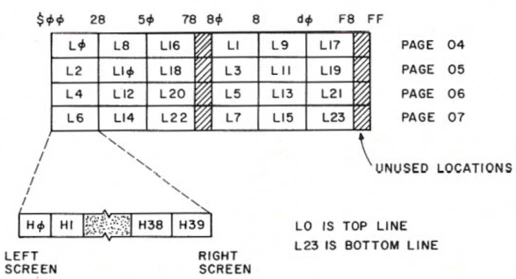

Fig. 4. Display memory locations of Apple II shown as hex map.

	H0	H39
V0	1024	1063
	1152	1191
V2	1280	1319
	1408	1447
V4	1536	1575
	1664	1703
V6	1792	1831
	1920	1959
V8	1064	1103
	1192	1231
V10	1320	1359
	1448	1487
V12	1576	1615
	1704	1743
V14	1832	1871
	1960	1999
V16	1104	1143
	1232	1271
V18	1360	1399
	1488	1527
V20	1616	1655
	1744	1783
V22	1872	1911
	2000	2039

Locations *not* on screen
1144-1151
1272-1279
1400-1407
1528-1535
1656-1663
1784-1791
1912-1919
2040-2047
Each horizontal row is numbered
sequentially from left to right

Fig. 5. Display memory locations of Apple II shown as decimal locations.

of the Apple II display memory locations. Their mapping is somewhat similar to the memory repacking done in the KIM systems in *The Cheap Video Cookbook* (Sams 21524). Apple chose to stuff three lines per each half of a 6502's page of 256 words.

Apple uses a 40-character horizontal line numbered left to right from 0 to 39. They use a 24-row vertical field numbered top to bottom from 0 to 23.

Fig. 4 is fine for all us machine-language freaks. But integer BASIC works in decimal numbers, and it's not at all obvious what goes where. Fig. 5 is a remapping of the Apple II screen showing us what portion of the memory goes where on the screen, in decimal numbers. For instance, decimal character location 1706 is the third character from the left on the fourteenth line down from the top.

These sure are strange numbers. They were picked to simplify the internal Apple II system timing. As you can see, if you just try to sequentially put stuff on the screen, you'll put down the top line, then the ninth line down, then the seventeenth. Then you'll lose eight characters down the drain somewhere. Then onto the second, tenth, eighteenth lines. Then lose eight more characers. Messy, yes, but a great hardware simplification.

As a general rule, if you can't use hardware to simplify software, then you use software to simplify hardware. One or the other. Works every time.

Suppose a programmer would like to have a variable H for the horizontal position with a 0 to 39 range and a variable V for the vertical position ranging from 0

```
 10 REM THIS APPLE INTEGER BASIC PROGRAM DISPLAYS LOWER CASE CHARACTERS. USE ESC
        TWICE FOR SHIFT LOCK. USE ESC ONCE FOR SHIFT OR RELEASE.
100 FOR CURS = 2000 TO 2039
110       CHAR = PEEK ( - 16384): IF CHAR<127 THEN 110: POKE ( - 16368),0
120                 IF CHAR = 141 THEN 180 .: REM CR
130                 IF CHAR = 155 THEN 190 : REM ESC
140                 IF CHAR> 192 AND SHIFT = 0 THEN CHAR = CHAR - 192
150       POKE, CURS, CHAR
160                 IF LOCK = 0 THEN SHIFT = 0
170 NEXT CURS
180 CALL - 912: GOTO 100: REM SCROLL
190 IF LOCK = 0 THEN 200: LOCK = 0: SHIFT = 0: GOTO 110: REM RELEASE LOCK
200 IF SHIFT = 0 THEN 210: LOCK = 1: GOTO 110: REM SET LOCK ESC #2
210 SHIFT = 1: GOTO 110: REM SHIFT ON ESC #1
```

Program B. Lowercase display program to fill the screen with combined upper and lowercase text via bottom line entry. SCROLL and RETURN work. No visible cursor or upper screen access.

```
H = Horizontal position 0(left) to 39(right)
V = Vertical position 0(top) to 23(bottom)
  For lines 0-7:
      Address = 1024 + (128•V) + H
  For lines 8-15:
      Address = 1064 + (128•(V − 8)) + H
  For lines 16-23:
      Address = 1104 + (128•(V − 16)) + H
```

Fig. 6. One method of calculating Apple II display addresses.

to 23. Obviously, we need a way to go from the H and V locations to the magic display memory addresses.

The Apple II monitor does this in the firmware with a disgustingly elegant sequence, BASCALC, starting at hex $FBC1. BASCALC takes the H value in $24 and the V value in $25 and puts the result BASL in $28 and BASH in $29. Thus, the programmer uses H and V, while the machine hardware uses BASL and BASH, and everybody is happy.

Unfortunately, quite a bit of PEEKing, POKEing, pushing and shoving is involved to call this sequence from integer BASIC. Instead, let's find a BASIC way to generate the right addresses.

Fig. 6 shows the math needed to find a particular address on the screen. The formulas are in three parts, depending on what third of the screen you happen to be on. To find a screen location, just use one of these formulas, and the results should agree with Fig. 5.

You can, of course, program these formulas into integer BASIC—and it's fun to do—but we need something faster and simpler. Fig. 7 shows us a lookup table to do the same thing. We store the leftmost address for the 24 lines as an array of values called B(V), meaning "Base address for line #V." To this, we add the horizontal value and get a result, CURS, that has the correct display address for a given H and V.

Note that there are two ways to enter the program. The first time you enter, you have to set up the B(V) array and initialize all the values. It's recommended you do this every time you clear the screen to make sure this table is intact. After we are sure the table is properly stashed, we can enter at 2000, and do the simple one-line CURS calculation shown in 2020. It is very important to be sure that the V and H values are, in fact, on the screen. Otherwise, you might end up POKEing a character into memory somewhere off the screen, plowing up a program or some operating system. This is why you should check H and V (lines 2000 and 2010) immediately before you use them.

A Software Cursor

There doesn't seem to be an obvious way to keep Apple II compatibility and be able to use the hardware cursor to wink lowercase. So, a software cursor can be used instead. Fig. 8 shows us how to combine your keyboard scanning with a cursor routine that winks any character on the screen by replacing the character with a solid box, repeating a few times a second.

A single loop is used to both provide a cursor and test for pressed keys. If no key is pressed, the loop will continue.

On the first trip through the

```
initial
enter   1000 DIM B(64)
        1010 B(0) = 1024:B(1) = 1152:B(2) = 1280:B(3) = 1408:
             B(4) = 1536:B(5) = 1664:B(6) = 1792:B(7) = 1920
        1020 B( 8) = 1064:B( 9) = 1192:B(10) = 1320:B(11) = 1448:
             B(12) = 1576:B(13) = 1704:B(14) = 1832:B(15) = 1960
        1030 B(16) = 1104:B(17) = 1232:B(18) = 1360:B(19) = 1488
             B(20) = 1616:B(21) = 1744:B(22) = 1872:B(23) = 2000
usual
enter   2000 IF V>23 THEN V = 23: IF V<0 THEN V = 0
        2010 IF H>39 THEN H = 39: IF H<0 THEN H = 0
        2020 CURS = B(V) + H
```

Fig. 7. An integer BASIC sequence to find Apple II display memory locations. For cold start, enter and initialize sequence at 1000. To find a location after initialization, enter at 2000. CURS will carry the correct display location to the instruction following 2020.

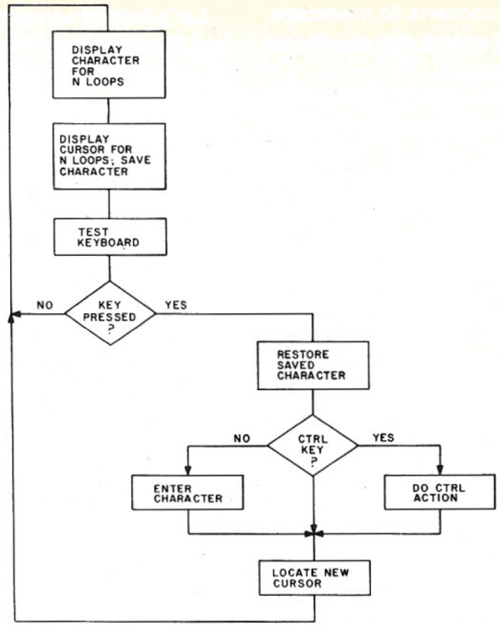

Fig. 8. Flowchart for an editing display that combines a winking software cursor within the keyboard testing loop.

loop, the cursed character is temporarily saved and is then replaced with a box cursor. On the 12th trip through the loop, the box cursor is removed and replaced with the saved character. On the 24th trip through the loop, the sequence repeats.

So long as no key is pressed, a winking cursor appears on the screen. When a key finally is hit, the cursor is immediately erased and replaced with the correct character. If things happen to be on the second half of the loop, the character simply replaces itself. At any rate, when we are sure we have a pressed key, we make sure the cursor goes away.

The key is then tested to see if it is a character or a machine command. If it is a character, it is entered. If it's a machine command, the command is acted on if valid and ignored if not.

The new cursor location is found only after character entry or machine command actions are complete. The program then jumps back to the main loop, testing for pressed keys and winking the cursor. Cursor winking speed is software adjustable.

One interesting feature of the combined cursor and keycheck loop is that the cursor always goes on the instant after a new location appears. This is much cleaner looking and easier to follow than the "aliasing" that sometimes takes place with rapid motions of a hardware-blinked, asynchronous cursor.

A Full Dual-Case Editing System

Program C shows a medium-complexity full-editing system that puts uppercase and lowercase characters anywhere you want on the screen, with full cursor motions. Features included are uppercase and lowercase, clearing, normal entry, cursor right-left-up-down, carriage return, scrolling, erase to end of line, erase to end of paragraph, lowercase shift and shift lock. Four "hooks" are provided to interact with your disk or hard-copy system or to add other features. It's a simple matter to add all the extras you want.

In lines 100 through 200, we set up the base address file for our screen address finder. These values are rechecked every time the screen is erased. Line 140 gives us a clear screen on startup and when called for. It uses the clearing sequence already in the monitor. Lines 160 through 180 find valid cursor locations for us, starting with H and V positions.

Our combination cursor loop

and keyboard test appears in lines 200 through 280. A cursor-counting variable, CCNT, counts from 0 to 24 for us. On count #1, the character being cursed is stored temporarily as CSTR. The cursor box (an ASCII 63, DEL) is loaded in its place. On CCNT count #12, the original character is replaced. On CCNT count #24, the cycle repeats. Meanwhile, the keyboard has been checked for a pressed key 24 times. You can think of CCNT as a divide-by-24 counter that is clocked by the keyboard testing. By changing the numbers, you can change the winking rate and the ratio of cursor to character time.

Once a key is pressed, we reset the keyboard strobe and make sure the cursed character has been put back where it belongs. Line 270 does this for us. Then, 280, we test for CTRL keys.

If the pressed key happens to be a character, line 300 decides whether lowercase or uppercase is to be displayed. Line 310 releases shift after a capital letter unless the shift is locked.

Actual character entry takes place in 400, while the cursor is adjusted in 410 and 420. If we go off-screen to the right, H is reset to 0 and V is incremented down-screen by one. If V goes off-screen, we call for a scroll, using the firmware scroll sequence in the monitor. After repositioning the cursor, the program returns to the main cursor and keycheck loop by jumping to 160. At this time, the cursor starts winking in the new location.

CTRL keys are processed in lines 1000 to 1040. Most are obvious. Line 1000 is needed so you can use the firmware erase-to-end-of-screen in the monitor; this step transfers the BASIC H and V values to the slots in the monitor where they are needed. Unfortunately, the monitor's erase-to-end-of-line firmware sequence doesn't seem to be as useful (it doesn't calculate its own base address), so this shorter erase sequence is done on our own in line 1080.

The spare hooks are shown in 1100 through 1130. Simply replace 160 (return-to-keyboard-loop) with the location you need for access to your disk, printer or other program. About a dozen other hooks can be added, just by picking new CTRL commands from Fig. 3. Remember that CTRL-C is excluded as this returns you to the integer BASIC operating system.

Should no valid CTRL key be found, the jump in 1140 puts us back into the keyboard checking business.

Lines 2000 through 2020 do the now familiar ESCAPE processing for the lowercase shift lock. As before, a single ESCAPE gives one capital letter. Two in a row locks us into capitals only. Should we be locked into capitals only, the next ESCAPE unlocks back to lowercase.

Some Extras

You can add just about anything you like to this editor program. For super-easy editing, you might like to add an additional keypad that generates all the motion commands with a single keystroke each. This heavyweight modification would be handy for word processing, typesetting and so on.

It's fairly obvious how you would add diagonal and cursor home motions, cursor OFF-ON, tabs, etc. To do really fancy editing, you have to be able to add and delete characters. How you do this depends on the rules you choose to set up for your particular system. Several full editors are available as software packages that may be of help to you.

A simple example of a delete-character subroutine is shown in Program D. Starting at the cursor plus one, every character on the line is moved one to the left. When this is finished, the last character will be repeated twice. The duplicate end character is then erased. The repeated moves take place in the 4000 to 4030 loop, while the end-character erasure happens in step 4040. This particular delete-character sequence

```
  10 REM  EDITING DUAL CASE DISPLAY SYSTEM FOR APPLE II
  20 REM  CLEAR = CTRL X           CURSOR RIGHT = RIGHT ARROW
          SHIFT = ESCAPE           CURSOR LEFT = LEFT ARROW
          LOCK = ESCAPE X2         CURSOR UP = CTRL A
  30 REM  UNLOCK = ESCAPE          CURSOR DOWN = CTRL B
          RETURN = RETURN          ERASE EOL = CTRL D
          HOOKS = CTRL Q,R,S,T     ERASE EOP = CTRL W
 100 DIM B(64): REM SET UP BASE ADDRESS TABLE
 110 B(0) = 1024:B(1) = 1152:B(2) = 1280:B(3) = 1408:
     B(4) = 1536:B(5) = 1664:B(6) = 1792:B(7) = 1920
     B(8) = 1064:B(9) = 1192:B(10) = 1320:B(11) = 1448
 120 B(12) = 1576:B(13) = 1704:B(14) = 1832:B(15) = 1960
     B(16) = 1104:B(17) = 1232:B(18) = 1360:B(19) = 1488
     B(20) = 1616:B(21) = 1744:B(22) = 1872:B(23) = 2000
 140 CALL -936: H = 0: V = 0: REM CLEAR SCREEN; HOME CURSOR
 160 IF V>23 THEN V = 23: IF V<0 THEN V = 0
 170 IF H>39 THEN H = 39: IF H<0 THEN H = 0
 180 CURS = B(V) + H: REM FIND CURS ADDRESS AFTER VALID V,H
 200 CCNT = 0
 210 CCNT = CCNT + 1
 220 IF CCNT>1 THEN 240: CSTR = PEEK (CURS)
 230        POKE (CURS),63: REM SAVE CHAR; WRITE CURSOR
 240 IF CCNT = 12 THEN POKE CURS,CSTR
 250 IF CCNT>23 THEN CCNT = 0: REM UNWINK CURSOR
 260 CHAR = PEEK (-16384): IF CHAR<127 THEN 210
 270        POKE (-16368),0: POKE CURS,CSTR
 280        IF CHAR<160 THEN 1000: REM CTRL KEY TEST
 300 IF (CHAR>192 AND SHIFT = 0) THEN CHAR = CHAR - 160: REM LOWER CASE ONLY IF
     UNSHIFTED CAPITAL LETTER
 310 IF LOCK = 0 THEN SHIFT = 0: REM RETURN TO LOWER CASE IF UNLOCKED
 400 POKE CURS, CHAR: REM ENTER CHAR
 410        H = H + 1: IF H<40 THEN 160: H = 0: REM ADJ H POS
 420 V = V + 1; IF V>23 THEN CALL -912: GOTO 160: REM ADJ V POS; SCROLL IF OFF SCREEN
1000 POKE 36,H: POKE 37,V: REM TRANSFER HV TO MONITOR FOR EOS
1010 IF CHAR = 152 THEN 100: REM CLEAR AND HOME ON CTRL X
1020 IF CHAR #141 THEN 1030: H = 0: V = V + 1: IF V>23 THEN CALL -912: REM CARRIAGE
     RETURN. SCROLL IF OFF SCREEN.
1030 IF CHAR = 136 THEN H = H - 1: REM BACKSPACE ON ARROW
1040 IF CHAR = 139 THEN H = H + 1: REM ADVANCE ON ARROW
1050 IF CHAR = 129 THEN V = V - 1: REM CURSOR UP ON CTRL A
1060 IF CHAR = 130 THEN V = V + 1: REM CURSOR DOWN ON CTRL B
1070 IF CHAR = 155 THEN 2000: REM ESCAPE SHIFT SEQUENCE
1080 IF CHAR #132 THEN 1090: FOR H1 = H TO 39: POKE (B(V) + H),63: NEXT H1: REM ERASE TO
     END OF LINE ON CTRL D
1090 IF CHAR = 151 THEN CALL -958: REM MONITOR ERASE EOS ON CTRL W
1100 IF CHAR = 145 THEN 160: REM SPARE HOOK ON CTRL Q DC1
1110 IF CHAR = 146 THEN 160: REM SPARE HOOK ON CTRL R DC2
1120 IF CHAR = 147 THEN 160: REM SPARE HOOK ON CTRL S DC3
1130 IF CHAR = 148 THEN 160: REM SPARE HOOK ON CTRL T DC4
1140 GOTO 160: REM RESUME KEYBOARD SCAN ON UNUSED CTRL COMMAND
2000 IF LOCK = 0 THEN 2010: LOCK = 0: SHIFT = 0: GOTO 160: REM RELEASE LOCK
2010 IF SHIFT = 0 THEN 2020: LOCK = 1: GOTO 160: REM SET LOCK ON SECOND ESCAPE
2020 SHIFT = 1: GOTO 160: REM SHIFT ON FIRST ESCAPE
```

Program C. Full lowercase Apple II editing display system.

operates only on a single line. Lines further down the screen are not affected.

Inserting extra characters is a more difficult problem, since everything has to be shoved around the screen to make enough room. Once again, you have to pick the shoving rules you want to use for your particular editing needs.

One possibility, insert-a-character subroutine, is shown in Program E. This uses a rule that says it will keep bumping characters until it finds a line whose last character is a space. Usually, this will be the line you are working on, but if not, characters will keep getting bumped till a space at the end of a line is found. Then the bumping stops and the rest of the screen stays the way it was.

Here are the steps involved in this insert-a-character sequence:

1. A check is made to find out how many lines are involved, till one is found with a space at the end (lines 3000 to 3040).

2. Everything on the bottommost line to be bumped shifts one to the right. Remember that at least the rightmost character is a space on this line.

3. There will be a double character at the left of the line, provided it's not the one that had the cursor on it. This double character is replaced with the last character on the previous line (3160, 3170).

4. The process repeats as often as needed for all but the top line to be bumped. The loop is done with line 3100.

5. The line with the cursor on it gets characters bumped only from the cursor to the end of the line and has no need to borrow a character from a previous line. The change in policy for the cursed line is handled by line 3110.

6. Finally, everything will be bumped, but a duplicate character will remain at the cursed location. This dupe is erased in line 3190.

This is a fairly simple inserter that works fairly well and reasonably fast. If you don't like its rules, change them to suit yourself. The sequence is rather slow if you use it over and over again, as you might while justifying a whole page of text. You should be able to speed it up considerably if you want. The rule selected does have one possible bug in it—repeated insertions can swallow end spaces and run words together, since the next line bumping takes place with a character in the last slot and does not if a space is there. Requiring two spaces at line end may help. There are all sorts of other options, depending on what you want your particular editor to do.

```
4000  FOR H1 = H TO 38
4010        CURM = B(V) + H1
4020        POKE CURM,PEEK (CURM + 1): REM MOVE ONE LEFT
4030  NEXT H1
4040  POKE (B(V) + 39),160; REM BLANK END CHAR
4050  RETURN
```

Program D. BASIC subroutine to delete a single character on the Apple II display. It starts at the cursed location and moves everything on its own line left one character. The last character is erased.

```
3000 V2 = 0: H2 = 0
3010 FOR V1 = V TO 23: REM FIND FIRST END SPACE
3020      CEND = PEEK(B(V1) + 39)
3030      IF CEND = 160 THEN 3100
3040      V2 = V2 + 1: NEXT V1
3100 FOR V1 = (V2 + V) TO V STEP  - 1: REM: NEXT LINE
3110      IF V1 = V THEN H2 = H
3120      FOR H1 = 38 TO H2 STEP  - 1: REM SHIFT A LINE
3130           CURM = B(V1) + H1
3140           POKE (CURM + 1), PEEK (CURM)
3150           NEXT H1
3160      IF V1 = V THEN 3180: REM MOVE (V1 - 1),39 TO V1,0
3170           POKE B(V1),PEEK (B(V1 - 1) + 39)
3180      NEXT V1
3190 POKE ( B(V) + H), 160: REM: DELETE CHARACTER
3200 RETURN
```

Program E. BASIC subroutine to insert a single character on the Apple II display. It starts at the cursed location. It finds the first available characters as needed. The cursed character is then erased.

Your turn: Add the following extras to your editing program:

- *Ragged justify right—in which whole words are never broken on the right side of the screen and you can continuously type without carriage returns.*
- *Flush justify right—in which everything ends up square on the right side of the screen as needed for typesetting. What hyphening and short-line rules will you use for this?*
- *Variable character lines—in which you can go as long as 80 characters for text and form letter editing.*

As a hint to longer lines, just select *pairs* of lines when they are needed and act on these line pairs. Thus you should be able to output up to 80 characters for a business letter or a manuscript to your hard copy, while still viewing the results on a normal 40-character Apple up to you since the results are application specific. Have fun with all this.

Further Hardware Mods

Some of the more popular Apple II software uses the screen-reversal feature. This software may not be reasonably displayed with the hardware mods we've shown you so far. The checkbook program is one example, where deposits are shown reversed as black on white numerals. Is there some way we can still run these programs *and* have lowercase?

One obvious way is to use a switch to select *either* screen reversal *or* lowercase. Fig. 9 shows where this switch goes. Only an SPST switch and a resistor need be added to the existing modifications. This switch can be mounted along the right side of the circuit board far enough to the rear that it is easily reached. A miniature slide switch held in place with double-stick foam should do the trick.

The switchover works by providing a DL6 signal to A11 and A13 for uppercase and a logic 1 for screen reversal. If we provide DL6, we get lowercase since A11 forces the lowercase ASCII bit 6 output, and A13 inhibits screen reversal. If we provide a logic 1, lowercase is inhibited and reversal is allowed when it is called for.

You put the switch in the reverse position for programs that need reverse video continuously displayed. You put the switch in the lowercase position when you must display lowercase.

Your turn: The character generator in module A also will display CTRL characters if you make DL5 and ASCII bit 6 both zeros. When would you want to display control characters? How can you do this? Can you eliminate the changeover switch and replace it with a series of software flags that gives you everything at once—reversal, full case blinking, lowercase, CTRL displayed on command and invisibility on existing software?

Note that you can also use other character generators by suitably changing the pins around. There's also a lowercase 2513 you can piggyback onto the exisiting uppercase one.

You can also use your own character generator by burning your own 2716 EPROM. The advantages of the EPROM are that you can get any character and lots of graphics symbols that you like on a hardware basis. For instance, instead of the awkward treatment of the descenders on the lowercase g,

p, and so on, you could use 5×7 uppercase for caps and 5×5 uppercase for lowercase. This can be both legible and attractive.

There is one limitation to the 2716 when you use it with an only slightly modified Apple II. With the Apple II, only five output lines are used, with the remaining three being permanent blanks. Unless you rework the output video, your 2716 would be more suited to new characters than to graphics symbols that have to butt against each other. ■

Apple II conversion kits, TVT 6-5/8 Module As, *Cheap Video Cookbooks* and other cheap video stuff are available from:
PAIA Electronics
1020 West Whilshire
Box 14359
Oklahoma City OK 73114

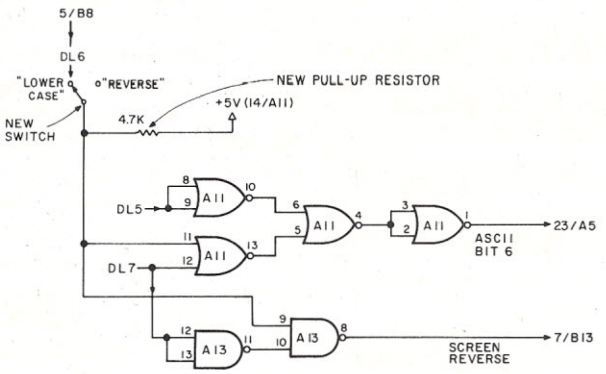

Fig. 9. A changeover switch and pullup resistor may be added to give an option of lowercase or reverse video displays.

✓ Reader Service—see page 227

Finding the Crash Site: A Simple Tracer for the 8080

Sometimes an unorthodox hardware mod can greatly simplify a complex programming task.

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Our college has a large Imsai system with a disk-based CP/M software package. We also have an Altair 8800 with Teletype and cassette interfaces, which we use for projects requiring portability, such as laboratory work, theatre lighting and electronic music.

One of the nice things about the big system is the Trace command in the DDT debugging package. This program takes control over the program being debugged and displays the program counter and register contents after every program step. I found myself wanting this capability on the smaller Altair system.

It really came to a head when I couldn't get the Mits BASIC tape to run on the Altair because the non-Mits serial I/O boards used different conventions than were provided for on the tape. To patch the program was more practical than changing the I/O hardware; it seemed the answer was a tracer to find the endless loops that were trying to read the wrong status bits.

Writing a tracing routine looked as though it would be quite a job, but then I recalled other occasions when doing something a little unorthodox with the hardware greatly simplified a software problem. How about using an interrupt to call the tracer routine after every step in the program being debugged? That way the tracer itself would not control execution of the object program; instead, control would alternate between the object program and the tracer.

I thought it was a pretty clever idea until I realized that when the tracer routine reenabled the interrupt on the 8080, the first thing it would trace would be its own RET instruction. Everything considered, it didn't seem very useful.

Hardware Solution

The solution to the problem came from my looking at the specifications for the 8080 and realizing that some of the status signals could help. Since the Altair bus uses an active low interrupt signal, $\overline{\text{PINT}}$, what I needed was a line that would be low most of the time but would be high immediately after the return from the tracer subroutine. The stack status signal, SSTACK, was just right. There couldn't be a simpler hardware modification.

Wires from bus lines 73 ($\overline{\text{PINT}}$) and 98 (SSTACK) were run to the unused AUX switch on the front panel of the Altair.

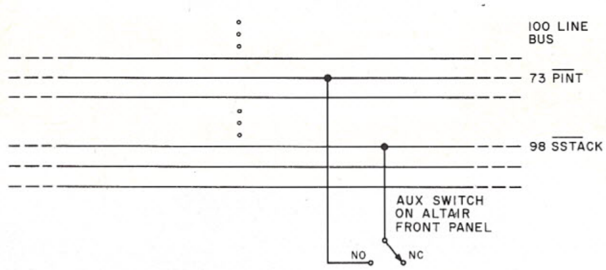

Fig. 1. The drastic modifications needed to implement the tracer scheme.

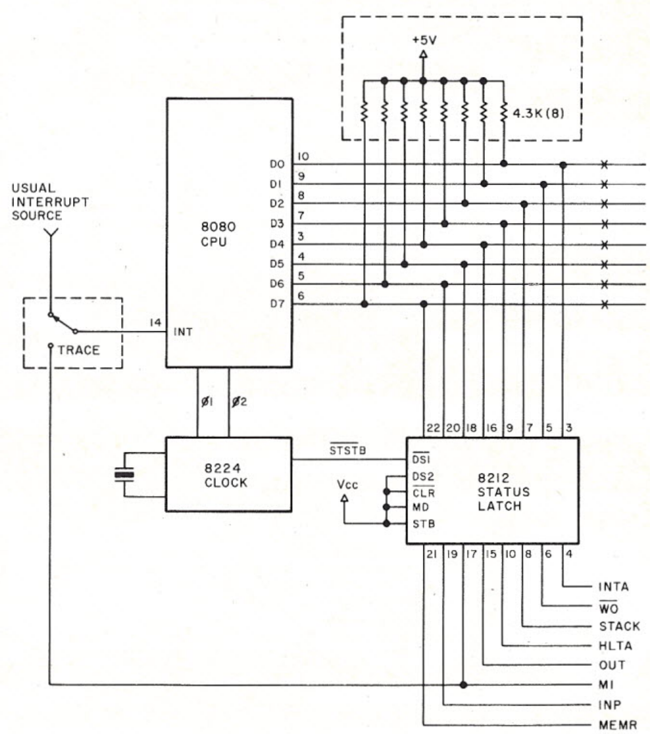

Fig. 2. Many home-brew or non-Altair-compatible 8080 systems will have a CPU interface resembling this circuit. To implement a tracer, pull-up resistors must be added to the unbuffered CPU data bus, and a switch should be installed to allow the M1 status signal to control the 8080 interrupt line.

TRACE	SHLD HSTORE	stow the contents of the H and L registers
	POP H	get the return address (program counter when interrupted) off the stack
	PUSH PSW	stow accumulator and flags
	MOV A,H	
	CALL OCTPRINT	print high byte of address
	MOV A,L	
	CALL OCTPRINT	print low byte of address
	MVI A,040_8	
	CALL ASCPRINT	print an extra space for clarity
	POP PSW	restore accumulator and flags
	PUSH H	put return address back onto stack
	LHLD HSTORE	restore H and L registers
	EI	enable interrupt
	RET	
HSTORE	DB	two bytes reserved for storing con-
	DB	tents of H and L registers
START	EI	to start tracing, load the address of
	JMP OBJ	the start of the object program here

Program A. A TRACE program for the 8080. A jump to the start of the TRACE routine must be stored at location 0-070_8. Two additional subroutines are needed. ASCPRINT interprets the contents of the accumulator as an ASCII character and prints or displays it. This subroutine should also take care of bookkeeping and insert carriage returns and line feeds as needed. OCTPRINT unpacks the contents of the accumulator and calls ASCPRINT to show the octal value of the accumulator byte. (See Program B.)

OCTPRINT	PUSH PSW	preserve registers
	PUSH B	
	MVI B,003_8	set up character counter
	ORA A	clear the carry flag
UNPACK	PUSH PSW	put shifted versions of accumulator on
	RAR	stack from right to left
	RAR	rotate three bits right
	RAR	
	DCR B	decrement character counter
	JNZ UNPACK	do this three times
	MVI B,003_8	reload character counter
ASCGEN	POP PSW	get last data first
	ANI 007_8	mask off all but low three bits
	ADI 060_8	convert to ASCII for numbers 0 to 7
	CALL ASCPRINT	print it
	DCR B	decrement the counter
	JNZ ASCGEN	do another until done
	MVI A,040_8	load code for space
	CALL ASCPRINT	print a space
	POP B	restore registers
	POP PSW	
	RET	

Program B. The OCTPRINT routine for unpacking a byte. If you prefer hexadecimal notation, a similar technique can be used.

With the momentary action switch in its normal open position, the computer runs exactly as it always did. When the switch is pressed, if the computer has executed an enable interrupt (EI) instruction, an interrupt is generated on the beginning of any instruction except those instructions immediately following an instruction that accesses the stack, such as a CALL, RET, PUSH, POP, RST or XTHL instruction.

The pull-up resistors on the data bus ensure the 8080 reads a RST 7 (377_8) when interrupted. This instruction calls the subroutine at location 0-070_8. Program A shows a simple tracer routine that will print out the program counter.

Anything so cheap and easy can't be entirely perfect, of course. The major limitation of this scheme is that it doesn't trace every step. I haven't found that a great disadvantage, however. Even though steps following a stack operation are not traced, there is no problem following the flow of a program. It is also not very difficult to write more sophisticated versions of the software—the routine of Program A is shown here because of its simplicity. It doesn't take much more programming to display all the registers or to restrict the printout to particular regions of memory.

Although the particular scheme suggested is very easy to implement on an S-100 bus, other systems will usually allow similar approaches, perhaps using different status signals. For example, on my home-brew 8080 system I have not defined an active low $\overline{\text{PINT}}$ signal. I could have used an extra inverter section to invert the STACK status signal to drive the 8080 INT line, but I didn't have a single extra gate or inverter on my CPU board. Instead I used the M1 status signal to drive the INT line.

In this implementation an interrupt and a call to the tracer are generated immediately after any instruction that makes only a single memory reference. This avoids the problem of calling the tracer immediately after its own RET instruction; yet, as with the version described for the Altair, enough steps in the object program are traced to clearly show what is happening.■

Chess I for Apple II

Writing a chess program is no easy task, the author discovered.

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When I first brought my Apple II home in the autumn of 1977, I had a total of four programs. *Four programs!* Well, they satisfied me for a time, but a personal computer owner does not live by Star Trek alone. I had become a compulsive program collector. The urge to acquire new programs became insatiable. A blank cassette was my constant companion.

Relief was on its way. My local Computerland's public program exchange library supplied me with about ten programs. Fellow Apple II owners have contributed to my software library. I have added about two programs per month to the growing stack of cassettes on my workbench.

However, my best source of programs is the personal computer periodicals. Where else can you get good-to-excellent quality programs at 2 1/2 bucks a shot? What's a little wear and tear on the fingertips when it saves wear and tear on the pocketbook? I happily pound away on my keyboard—changing, adapting, squeezing and adding code.

But nowhere in that five-foot pile of magazines was there a single chess program. It's not that I'm a computer chess fanatic, I just wanted a chess program to add to my collection. So I wrote one. Now I know why there wasn't a chess-playing program in all my magazines—writing one ain't easy!

Program Features

At the onset of the program's development, I decided to write it in BASIC. After all, didn't Apple's integer BASIC score high in *Kilobaud's* first BASIC benchmark article ("BASIC Timing Comparisons," *Kilobaud* No. 6, p. 66)? The choice later proved to be a wise one. The BASIC program development time was two and one-half months. I would never have finished the program if I had written it in machine language.

My design objectives were as follows:

1) Allow the opponent to play either the black or the white pieces.
2) Provide graphic representation of the board and pieces, both active and captured.
3) Automatic movement of pieces after move selection.
4) Permit castling to both the king and queen sides, capture en passant and automatic promotion of pawns to queens.
5) Disallow illegal moves by the opponent.
6) Provide random opening moves.
7) Play a fairly challenging chess game.

I feel that I have met all my design objectives in the program implementation. The program's opponent may control either the black or the white pieces using standard algebraic chess notation (see Fig. 1). The chessboard and pieces are constructed using ASCII characters and graphic symbols (see Fig. 2).

After the intended move is entered through the windowed text area under BLACK or WHITE, the piece is moved to its destination automatically. When a piece is captured, it will be moved from the playing board to the capture list.

All legal moves are permitted with edits rejecting invalid moves at input time. Program logic for opening moves will select only bishops, knights, king's pawn or queen's pawn as eligible pieces for random but valid moves.

As for the chess-playing ability of the program: It will give the casual chess player a good game. The logic is not inspired. The program is blind beyond two moves. However, it will gobble you up if you make a clumsy move. It will exercise your chess-playing skills.

I consider it a good base program that is eligible for further fine-tuning and development. Be warned if you plan to enhance the logic of the program: The existing program and its variables occupy all but 150 bytes of my 16K Apple II. The following two sections, Program Narrative and Variable Definitions, are your guides for program modification.

A note to you keyboard bangers: If you keyed it in correctly, and I suggest you key in the same order as the program flow, the program is not in a loop. It just takes two minutes to initialize that 4K master array M and one minute to scan the array for all possible moves.

Program Narrative

0-100 The program mainline.

1000-1100 Restart point used in program testing, which is entered via the direct command GOTO 1000.

11000 Tests if an enemy piece can occupy the same square that contains the program's king.

12000-12020 Determines if the program's king would be exposed to check by moving a given piece owned by the program.

13000 Weighs a protective blocking move more heavily if the program's king is in check.

14000-14999 Tests if the checking move, just entered by the human player, is valid. If the check is not valid, it is rejected. Else the traverse from the checking piece to the program's king is calculated and saved.

15000 Performs automatic

EXAMPLES TO:	ENTER:		
MOVE	D2 – D4		
CAPTURE	D4XE5		
CHECK	G3 – H3 +	OR	G3XH3 +
MATE	B2 – B5*	OR	B2XB5*
DRAW	G7 – G8 =	OR	G7XG8 =
CASTLE	0-0-0	OR	0-0
RESIGN	RESIGN		

Fig. 1.

promotion of pawns to queens when they reach their eighth rank.

16000-16040 Evaluates the threat to any of the program's pieces from the enemy piece just moved. A weighing factor is inserted into the element of the array E(15), which corresponds to that enemy piece.

17000-17110 Generates all moves for the program after the opening book subroutine (22000) relinquishes control of the program's pieces.

18000-18500 Determines if the program is now free to castle to the king's side. If the king and the king's rook are not yet moved and if no pieces lie between the king and its rook, then all needed castling parameters will be set.

19000 Examines the move just generated by the program to determine if it is a move that will put the enemy king into check.

20000 Ranks the program's king as the most valued of the program's pieces when it is in check.

21000-21001 Inserts a character string into the string variable MOV$, which is the algebraic notation of the move generated by the program.

22000-22110 Generates random opening moves for approximately the program's first six moves before giving control to the main move routine at 17000.

23000-23920 Sets the text window for displaying the program's moves, clears the windowed screen area and resets to full screen mode if the Boolean variable DEBUG is true. Tests if the program's king is in check and accordingly takes evasive action. Castles to the king's side if able, selects opening or middle game moves and tests if the move selected has placed the opposing king into check or will allow en passant capture by the opponent. Moves the selected piece and updates the appropriate sub-array in M(2047).

24000-24003 Removes a captured piece to the appropriate capture list and clears the corresponding sub-array of the master array M(2047).

25000-25007 Determines what squares are traversed and which squares are occupied on that traverse, in moving from one board position to another.

26000-26601 Updates a sub-array in the master array M(2047). The value of a given piece is taken from its current position in the board array B(63)

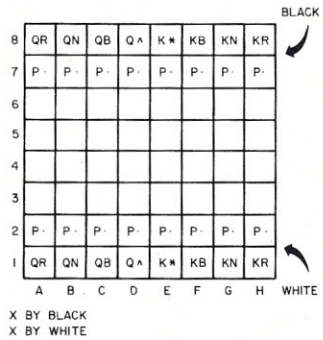

Fig. 2.

and is placed in the same relative position in its corresponding sub-array in the master array M(2047). The piece's value is also inserted into all elements of the sub-array that the piece can be moved to if no other pieces exist on the board.

26080 For a given position P, the routine calculates the index X into the arrays E(15), MVS(31) and S(31).

26090 Given a rank R and a file F, the routine determines if a square exists on the chessboard with that rank and file.

27000-27005 Prints the edited move just entered or generated. Resets the text window to full screen printing. Counts all moves made by both players. Handles en passant and normal captures. Moves pieces and updates the arrays MVS(31) and S(31). Performs castling moves and invokes the subroutines 24000 and 15000.

28000-28013 Prints the program title. Gives examples of moves in algebraic chess notation. Asks the player which set of pieces he wishes to play and edits his response. Sets the appropriate text window arrays for both the program and the human player. Choice of pieces is set in the variables H and A. Indices into all arrays are set for both players. The location

Program listing.

```
>
>
>LIST
    0 REM (C) 1978 BY LOU HAEHN
    1 TEXT : CALL -936:I=0:Z=I:Q=1:DEBUG=Z
   10 GOSUB 32000: REM DIM'S & INITS
   20 GOSUB 28000: REM GAME INITS
   30 GOSUB 31000: REM BOARD
   40 GOSUB 30000: REM PIECES
   50 IF A=Q THEN 90: REM WHITE 1ST
   60 GOSUB 29000: REM INPUT
   70 GOSUB 27000: REM MOVE PC
   80 GOSUB 26000: REM UPDATE MSTR
   85 GOSUB 16000: REM CP EVIL
   90 GOSUB 23000: REM APPLE
  100 GOTO 60
 1000 CALL -936: GOSUB 31000: FOR POS=Z TO 63:VFLG=NL: IF B(POS)
      >Q THEN VFLG=IV: GOSUB 30010: NEXT POS
 1100 DEBUG=Q: POKE 50,NL: GOTO 60
11000 OK=Z: FOR I=HX*64 TO HX*64+1000 STEP 64: IF M(I+S(II)) THEN
      OK=Q: NEXT I: RETURN
12000 OK=Q:I=4: IF AX THEN I=28:II=S(I):KK=HX*64: FOR JJ=KK TO
      KK+1000 STEP 64: IF NOT M(JJ+II) THEN 12020
12005 IF CK OR SCK THEN RETURN
12010 TO=II:FROM=S( ABS (M(JJ+II)/100)): GOSUB 25000: IF NOT O(
      Q) AND O=NF THEN OK=Z
12020 NEXT JJ: RETURN
13000 IF NOT P3 THEN RETURN : FOR IJ=Z TO 5: IF TK(IJ)=P2 THEN
      PS=PS+(10- ABS (P3))*60: NEXT IJ: RETURN
14000 II=4: IF AX THEN II=28: IF M( ABS (B(TO)/100)*64+S(II))=B(
      TO) THEN 14010: GOSUB 11000: IF OK THEN RETURN : GOTO 14999
14010 IF ABS (B(TO)) MOD 10=3 THEN RETURN :SCK=Q:FROM=S(II): GOSUB
      25000: FOR I=Z TO 5:TK(I)=T(I): NEXT I: RETURN
14999 PRINT "BAD +";: FOR I=Z TO 3000: NEXT I: PRINT :SCK=Z:CK=
      Z: RETURN
15000 IF TO>7 AND TO<56 THEN RETURN :B(FROM)=B(FROM)+ SGN (B(FROM)
      )*48: RETURN
16000 IF SGN (B(POSM))=A THEN RETURN :P=POSM: GOSUB 26080:II=X*
      64:X=X MOD 16:E(X)=2
16010 FOR JJ=II TO II+63: IF NOT M(JJ) THEN 16040:KK=JJ MOD 64
16015 IF E(X)>7500 THEN 16040
16020 FOR LL=Z TO 15: IF KK#S(LL+AX) THEN 16030:E(X)=(E(X)+ ABS
      (M(JJ) MOD 10))*4
16030 NEXT LL
16040 NEXT JJ: IF E(X)=2 THEN E(X)=Z: RETURN
17000 FOR P1=AX TO AX+15:NF=S(P1): IF NF<Z THEN 17110:P6=P1*64
17010 GOSUB 12000: IF NOT OK THEN 17110
17011 FROM=NF:PSE=Z:P3=B(NF) MOD 10: IF P3=A THEN 17020: IF NOT
      CK AND NOT P3 THEN 17110: IF NOT P3 AND CK THEN GOSUB 20000
17013 IF NOT CNT THEN 17020:P=SVT: GOSUB 26080: IF NOT M(X*64+NF)
      THEN 17020
17016 TO=S(X):O=Z: IF ABS (B(P) MOD 10)#3 THEN GOSUB 25000: IF
      NOT O THEN PSE= ABS (P3)*32
17020 FOR P2=Z TO 63: IF NOT M(P6+P2) THEN 17100: IF SGN (B(P2)
      )=A THEN 17100
17025 TO=P2:FROM=NF: GOSUB 25000: IF O THEN 17100:PS=PSE
17030 IF P3#A THEN 17050:P7= ABS (NF-P2) MOD 8: IF B(P2) AND NOT
      P7 THEN 17100: IF NOT B(P2) AND P7 THEN 17100: IF P7 THEN
      17050
17040 IF P2 MOD 8=Z OR P2 MOD 8=7 OR NOT P2 OR P2=63 THEN 17050
      : IF B(P2+Q) MOD 10=A OR B(P2-Q) MOD 10=A THEN 17100
17050 JJ=A*1024:II=HX*64: IF NOT B(P2) THEN 17065
17060 PS=PS+ ABS (B(P2) MOD 10)*32:P=P2: GOSUB 26080: IF X=EK THEN
      17100:X=X MOD 16:PS=PS+E(X)
17065 FOR P4=II TO II+1000 STEP 64:I=P4+P2
17066 IF NOT M(I) THEN 17079:TO=P2:FROM=S( ABS (M(I)/100)): GOSUB
      25000: IF NOT O AND PSE AND NOT B(P2) THEN PS=PS- ABS (P3)
      *39
17070 IF O AND B(P2) THEN PS=PS+ ABS (P3)*8: IF NOT O THEN PS=PS-
      ABS (P3)*39: IF B(P2) THEN 17071: GOTO 17079
17071 KK=FROM: FOR P5=II TO II+1000 STEP 64:I=P5+P2+JJ: IF NOT
      M(I) THEN 17078
17072 FROM=S( ABS (M(I)/100)):TO=P2: GOSUB 25000: IF NOT O THEN
      PS=PS+ ABS (B(KK) MOD 10)*25
17078 NEXT P5
17079 NEXT P4: IF NOT P3 THEN 17085
```

of the enemy king is found and saved.

29000-29051 Sets the text window for input, clears the windowed screen area and accepts the desired move. Edits for proper length of input text and correct algebraic notation. Prevents: movement of the program's pieces, capture of one's own pieces, capture of the program's king, invalid piece movement and movement into an occupied position if capture is not specified. Allows legal en passant capture.

30000-30001 Prints all the chess pieces and initializes all of the sub-arrays in the master array M(2047).

30010-30011 Calculates the vertical and horizontal positions needed to print within a given square on the chessboard. Sets the proper video display mode and prints the desired two-character graphic symbol for a given chess piece.

31000-31007 Sets text mode and clears the screen. Prints the chessboard, algebraic notation indicators, the text window captions and the two capture list titles.

32000-32016 Dimensions all arrays and string variables used by the program. Initializes string constants for game board and piece generation. Defines all valid moves in algebraic notation. Places all pieces into the board-display array B(63).

8	0	1	2	3	4	5	6	7
7	8	9	10	11	12	13	14	15
6	16	17	18	19	20	21	22	23
5	24	25	26	27	28	29	30	31
4	32	33	34	35	36	37	38	39
3	40	41	42	43	44	45	46	47
2	48	49	50	51	52	53	54	55
1	56	57	58	59	60	61	62	63
	A	B	C	D	E	F	G	H

Fig. 3.

Sets constants for normal, flashing and inverse video mode. Defines text window parameters for displaying moves in algebraic notation. Zeroes counters for the current number of moves for a given piece. Notes which square every piece occupies.

32766 Prints the current number of bytes of memory used by the program in a 16K Apple II by accessing the address pointers of the integer BASIC interpreter.

Variable Definitions

A—Apple; integer variable equal to −1 if the program is to play the black pieces or equal to +1 if the program is to play the white pieces. This variable is equal to the sign of the numbers which represent the pieces owned by the program. Related variables: ACS, AX, EPA.

**A$(1)**—Work string variable used in extracting sub-strings from the string MOV$. Related variables: B$, MOV$, V$.

ACS—Apple castle status; Boolean variable equal to 1 if the program has castled or equal to 0 if the program has not yet castled. Related variables: A, CS.

AX—Apple index; integer variable equal to 0 if the program is controlling the black pieces or equal to 16 if the program is controlling the white pieces. Used to index into the arrays M, MVS and S. Related variable: A.

B(63)—Board array; array variable representing the displayed chessboard. See Fig. 3 for the relationship of the indices to the square of the board. An element is nonzero if its corresponding square of the board contains a black or white piece. The color of a given piece is determined by the sign of the number representing that piece: black if less than zero and white if greater than zero. The point value for each piece is the absolute value of the units digit of the number. The relative index of the piece's graphic symbol, in the string variable PC$, is the absolute value of the tens digits. The absolute value of the hundreds and thousands digits is used as an index into the arrays MVS(31) and S(31). Related variables: E(15), M(2047), X.

**B$(1)**—Work string variable used in extracting sub-strings from the string MOV$. Related variables: A$, MOV$, V$.

CF—Castle from; integer variable equal to the starting board position of the rook

```
17080 J=S(EK):PS=PS+16- ABS (J/8-TO/8)- ABS (J MOD 8-TO MOD 8)
17081 P=NF: GOSUB 26080:PS=PS+16-MVS(X)/2
17085 IF SCK THEN GOSUB 13000: IF P3=A THEN PS=PS+ RND (4)
17090 IF PS<=NS THEN 17100:NT=P2:NS=PS
17100 NEXT P2: IF NS<=OS THEN 17110:OT=NT:OF=NF:OS=NS
17110 NEXT P1:TO=OT:FROM=OF: RETURN
18000 J=AX+AX/2+4:I=S(J): IF B(I+Q) OR B(I+2) THEN RETURN
18010 IF MVS(J) OR MVS(J+3) THEN RETURN : IF CNT<14 AND RND (6)
       THEN 18500
18020 J=HX*64: FOR L=J TO J+1000 STEP 64: IF M(L+I+Q) OR M(L+I+
      2) THEN RETURN : NEXT L
18500 CS=Q:ACS=Q:FROM=I:TO=I+2:CF=I+3:CT=I+Q: RETURN
19000 O=Z:J=S(EK):TR=J/8:FR=TO/8:TF=J MOD 8:FF=TO MOD 8:L= ABS
      (B(FROM)) MOD 10
19010 IF L#3 THEN 19060: IF FF>Q AND TO-10=J OR TO+6=J THEN CK=
      Q
19020 IF FF>Z AND TO-17=J OR TO+15=J THEN CK=Q
19030 IF FF<6 AND TO-6=J OR TO+10=J THEN CK=Q
19040 IF FF<7 AND TO-15=J OR TO+17=J THEN CK=Q: IF CK THEN 19110
       : RETURN
19060 I=Z: IF TR=FR THEN I= SGN (J-TO): IF TF=FF THEN I= SGN (J-
      TO)*8: IF I THEN 19080
19070 I= SGN (TR-FR)*8: IF TF>FF THEN I=I+Q: IF TF<FF THEN I=I-
      Q
19080 K=TO:N=Z
19090 K=K+I: IF K=J THEN 19100: IF K>63 OR K<Z THEN RETURN :N=N+
      Q: IF B(K) THEN O=Q: GOTO 19090
19100 IF NOT O THEN CK=Q: IF NOT CK THEN RETURN :I= ABS (I)
19101 IF L=Q AND N THEN CK=Z: IF L=Q AND (I=Q OR I=8) THEN CK=Z
19102 IF L=4 AND (I=Q OR I=8) THEN CK=Z
19103 IF L=5 AND (I=7 OR I=9) THEN CK=Z: IF NOT CK THEN RETURN

19110 RETURN : REM MATE LOGIC HERE
20000 P3=35*A:PSE=450:CK=Z: RETURN
21000 MOV$=V$(FROM*2+Q,FROM*2+2):MOV$(3)="-": IF CP THEN MOV$(3
      )="X"
21001 MOV$(4)=V$(TO*2+Q,TO*2+2): IF CK THEN MOV$(6)="+": IF MT THEN
      MOV$(6)="*": IF CS THEN MOV$="O-O": RETURN
22000 FOR P1=AX TO AX+15:NF=S(P1): IF NF<Z OR MVS(P1) THEN 22110

22010 I= ABS (B(NF) MOD 10): IF I=Z OR I=5 OR I=9 THEN 22110:FROM=
      NF:P3=I*A
22020 FOR P2=Z TO 63: IF NOT M(P1*64+P2) THEN 22100:TO=P2: GOSUB
      25000: IF O THEN 22100
22030 IF P3#A THEN 22050: IF B(P2) AND NF MOD 8=P2 MOD 8 THEN 22100

22040 IF SGN (B(P2))#H AND NF MOD 8#P2 MOD 8 THEN 22100: IF B(P2+
      Q) MOD 10=A OR B(P2-Q) MOD 10=A THEN 22100
22050 IF SGN (B(P2))=A THEN 22100:PS= ABS (P3)+ RND (3):I=HX*64
      : IF NOT B(P2) AND RND (2) THEN 22080
22060 PS=PS+ ABS (B(P2) MOD 10*8)
22070 FOR P4=I TO I+1000 STEP 64: IF M(P4+P2) THEN PS=PS- ABS (
      P3)/2: NEXT P4
22080 J=S(EK):PS=PS+16- ABS (J/8-TO/8)- ABS (J MOD 8-TO MOD 8)
22085 IF J3=A THEN PS=PS+Q
22090 IF PS<=NS THEN 22100:NT=P2:NS=PS
22100 NEXT P2: IF NS<=OS THEN 22110:OT=NT:OF=NF:OS=NS
22110 NEXT P1:TO=OT:FROM=OF: RETURN
23000 FOR I=0 TO 3: POKE 32+I,WA(I): NEXT I: CALL -936: IF DEBUG THEN
      TEXT : IF DEBUG THEN VTAB 21
23010 OT=Z:OF=Z:NT=Z:NF=Z:OS=-99:NS=OS:EPA=Z:EPC=Z
23020 IF NOT CK THEN 23040:SVT=TO: GOSUB 14000: GOSUB 17000:SCK=
      Z: GOTO 23900
23040 IF NOT ACS THEN GOSUB 18000: IF CS THEN 23900
23050 IF CNT>7+ RND (6) THEN GOTO 23070: GOSUB 22000: GOTO 23900

23070 SVT=TO: GOSUB 17000: REM CK MVS
23080 GOSUB 19000: REM FIND CK
23900 IF B(FROM) MOD 10=A AND ABS (TO-FROM)=16 THEN EPA=TO+(A*8
      )
23910 IF SGN (B(TO))=H THEN CP=Q: GOSUB 21000: GOSUB 27000
23920 POSM=TO: GOSUB 26000: RETURN
24000 IF B(TO)>0 THEN 24001:VFLG=NL: VTAB 24: TAB TW:TW=TW+2:POS=
      TO: GOSUB 30011: GOTO 24002
24001 VFLG=IV: VTAB 22: TAB TB:TB=TB+2:POS=TO: GOSUB 30011
24002 P=TO: GOSUB 26080:S(X)=-Q:X=X*64: FOR I=X TO X+63:M(I)=Z:
       NEXT I:CP=Z
24003 IF TW>36 THEN TW=37: IF TB>36 THEN TB=36: RETURN
25000 FOR I=Z TO 5:T(I)=Z:O(I)=Z: NEXT I:TR=TO/8:FR=FROM/8:TF=TO MOD
      8:FF=FROM MOD 8
25001 IF ABS (B(FROM) MOD 10)=3 THEN RETURN
25002 IF ABS (TR-FR)<2 AND ABS (TF-FF)<2 THEN RETURN
25003 I=Z: IF TR=FR THEN I= SGN (TO-FROM): IF TF=FF THEN I= SGN
```

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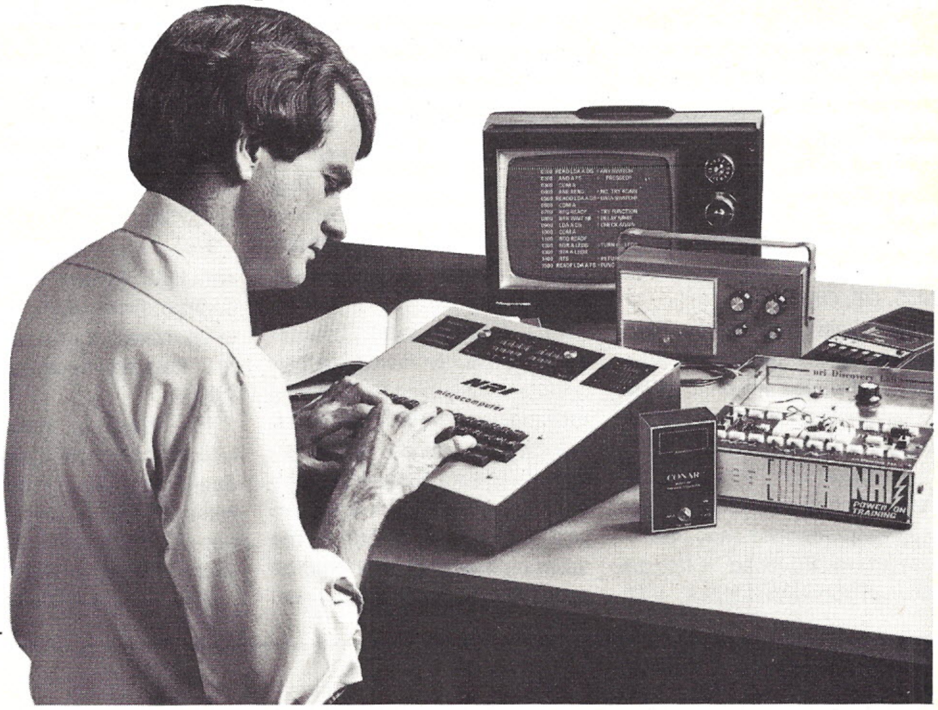

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which is about to be castled with the king. Related variables: ACS, CS, CT.

CK—Check; Boolean variable equal to 1 if a move by either player has caused the opposing king to be in check. Related variables: EK, SCK, TK.

CNT—Count; integer variable that is equal to the total number of moves made by both players. Related variable: MVS(31).

CP—Capture; Boolean variable equal to 1 if a move by either player involves a capture of an enemy piece. Related variable: EPC.

CS—Castle; Boolean variable equal to 1 if the current move by either player is a castling move. Related variables: ACS, CF, CT.

CT—Castle to; integer variable equal to final board position of the rook which is about to be castled with the king. Related variables: ACS, CS, CF.

D—Direction; integer variable which is equivalent to the only valid direction that a pawn may move. Equal to −1 if the pawn in question is black; +1 if the pawn is white. Related variables: B(63), POSM.

DEBUG—Boolean variable used during program development. Set to 1 if the program is reentered via the direct command GOTO 1000. Function: To allow the printing of the program's moves outside of its text window.

DR—Draw game; Boolean variable equal to 1 if a move is entered specifying a draw game.

E(15)—Enemy pieces; array variable corresponding to the 16 pieces that are in opposition to the program. The value of a given element increases according to the ability of that corresponding enemy piece to threaten any of the program's pieces. Related variables: B(63), POSM, X.

EK—Enemy king; integer variable used to locate the program's enemy king by indexing into the arrays B(63) and S(31).

EPA—En passant Apple; integer variable specifying the board position for a valid en passant capture of one of the program's pawns. It should be noted that no piece actually occupies this square. Related variables: EPC, EPH.

EPC—En passant capture position; integer variable equal to the square containing the pawn which is to be removed during an en passant capture. Related variables: EPA, EPH.

EPH—En passant human; integer variable equal to the board position for a valid en passant capture of one of the opponent's pieces. Related variables: EPA, EPC.

F—File; integer variable that represents the file, or column, of a given position on the board. Values are from 0 to 7. Related variables: B(63), FROM, R, POSM.

FF—From file; integer variable that represents the file, or column, from which a piece is to be moved. Values are from 0 to 7. Related variables: B(63), F, FROM.

FL—Flashing video mode; integer constant used to produce flashing video output when POKEd at decimal location 50 in the Apple's memory. Related variables: IV, NL, VFLG.

FR—From rank; integer variable that represents the rank, or row, from which a piece is to be moved. Values are from 0 to 7. Related variables: B(63), R, FROM.

FROM—Integer variable equivalent to the square from which a piece is to be moved. Related variables: B(63), FF, FR, TO.

H—Human; integer variable equal to −1 if the human opponent has elected to play the black pieces or equal to +1 if the white pieces have been selected. Related variables: EK, EPH, HX.

HX—Human index; integer variable equal to 0 if the human player has chosen the black pieces or equal to 16 if the white pieces have been chosen. Used to index into the arrays M(2047), MVS(31) and S(31). Related variable: H.

I—Integer work variable.

II—Integer work variable.

IJ—Integer work variable.

IM—Integer work variable.

IV—Inverse video mode; integer constant used to produce inverse video output when POKEd at decimal location 50

```
      (TO-FROM)*8: IF I THEN 25005
25004 I= SGN (TR-FR)*8: IF TF>FF THEN I=I+Q: IF TF<FF THEN I=I-
      Q
25005 K=FROM:J=-Q:N=Z
25006 J=J+Q:K=K+I: IF K=TO THEN RETURN
25007 T(J)=K: IF NOT B(K) THEN 25006:O(N)=K:N=N+Q: GOTO 25006
26000 IX= ABS (B(POSM)/100)*64:R=POSM/8:F=POSM MOD 8:D= SGN (B(
      POSM))
26001 FOR IM=Z TO 63:M(IX+IM)=Z: NEXT IM
26002 LOC=POSM: GOSUB 26090
26003 LOC=POSM: GOSUB 26090
26020 GOTO 26020+ ABS ((B(POSM) MOD 100)/10)
26021 GOTO 26100: REM P.
26022 GOTO 26200: REM QR
26023 GOTO 26300: REM QN
26024 GOTO 26400: REM QB
26025 GOTO 26500: REM Q^
26026 GOTO 26600: REM K*
26027 GOTO 26400: REM KB
26028 GOTO 26300: REM KN
26029 GOTO 26200: REM KR
26080 X= ABS (B(P)/100): RETURN
26090 OK=Q: IF R<Z OR R>7 OR F<Z OR F>7 THEN OK=Z:LOC=R*8+F: IF
      OK THEN M(IX+LOC)=B(POSM): RETURN
26100 R=R-D-D: IF NOT MVS(IX/64) THEN GOSUB 26090:R=R+D: GOSUB
      26090:F=F-Q: GOSUB 26090:F=F+2: GOSUB 26090: RETURN
26200 SR=R: FOR R=Z TO 7: GOSUB 26090: NEXT R:R=SR: FOR F=Z TO
      7: GOSUB 26090: NEXT F: RETURN
26300 R=R-2:F=F-Q: GOSUB 26090:F=F+2: GOSUB 26090:R=R+Q:F=F+Q: GOSUB
      26090:F=F-4: GOSUB 26090
26301 R=R+2: GOSUB 26090:F=F+4: GOSUB 26090:R=R+Q:F=F-Q: GOSUB
      26090:F=F-2: GOSUB 26090: RETURN
26400 SR=R:SF=F: FOR IM=Q TO 7
26401 R=SR-IM:F=SF-IM: GOSUB 26090
26402 R=SR-IM:F=SF+IM: GOSUB 26090
26403 R=SR+IM:F=SF-IM: GOSUB 26090
26404 R=SR+IM:F=SF+IM: GOSUB 26090
26405 NEXT IM: RETURN
26500 GOSUB 26400:R=SR:F=SF: GOSUB 26200: RETURN
26600 R=R-Q:F=F-Q: GOSUB 26090:F=F+Q: GOSUB 26090:F=F+Q: GOSUB
      26090
26601 R=R+Q: GOSUB 26090:R=R+Q: GOSUB 26090:F=F-Q: GOSUB 26090:
      F=F-Q: GOSUB 26090:R=R-Q: GOSUB 26090: RETURN
27000 PRINT MOV$; : TEXT :CNT=CNT+Q: IF NOT EPC THEN 27001:B(TO)
      =B(EPC):B(EPC)=Z:POS=EPC:VFLG=NL: GOSUB 30010
27001 VFLG=FL:POS=FROM: GOSUB 30010:POS=TO: GOSUB 30010
27002 FOR I=Q TO 1200: NEXT I: IF CP THEN GOSUB 24000: IF ABS (
      B(FROM)) MOD 10=Q THEN GOSUB 15000
27003 B(TO)=B(FROM):B(FROM)=Z:VFLG=NL: IF B(TO)>Z THEN VFLG=IV:
      POS=TO: GOSUB 30010:VFLG=NL:POS=FROM: GOSUB 30010
27004 P=TO: GOSUB 26080:MVS(X)=MVS(X)+Q:POSM=P:S(X)=P: IF CS THEN
      GOSUB 26000: IF CS THEN GOSUB 16000
27005 IF DR OR MT THEN END : IF NOT CS THEN RETURN :CS=Z:TO=CT:
      FROM=CF: GOTO 27001
28000 VTAB 11: TAB 13: PRINT "*** CHESS ***"
28001 PRINT : TAB 10: PRINT "WRITTEN BY LOU HAEHN"
28002 VTAB 24: PRINT "(C) 1978 BY L. HAEHN";
28003 FOR I=Z TO 1000: POKE 1978,I MOD 255: NEXT I: CALL -936: PRINT
      "*** EXAMPLES ***": VTAB 4: PRINT
28004 PRINT " TO:        ENTER:": PRINT " --          -----": PRINT
      : PRINT " MOVE      D2-D4": PRINT " CAPTURE  D4XE5"
28005 PRINT " CHECK     G3-H3+   OR  G3XH3+"
28006 PRINT " MATE      B2-B5*   OR  B2XB5*"
28007 PRINT " DRAW      G7-G8=   OR  G7XG8="
28008 PRINT " CASTLE    O-O-O    OR  O-O"
28009 PRINT " RESIGN    RESIGN"
28010 VTAB 19: CALL -958: INPUT "WHICH COLOR FOR YOU? ",MOV$: IF
      LEN(MOV$)=Z THEN 28010: IF MOV$(Q,Q)#"W" AND MOV$(Q,Q)#"B"
       THEN 28010
28011 IF MOV$(Q,Q)="B" THEN 28013: FOR I=Z TO 3:WH(I)=WW(I):WA(
      I)=WB(I): NEXT I
28012 H=Q:A=-Q:AX=Z:EK=28:HX=16: RETURN
28013 FOR I=Z TO 3:WH(I)=WB(I):WA(I)=WW(I): NEXT I:A=Q:H=-Q:AX=
      16:HX=Z:EK=4: RETURN
29000 FOR I=Z TO 3: POKE 32+I,WH(I): NEXT I: CALL -936: INPUT MOV$
      :L= LEN(MOV$): GOTO 29000+(L MOD 7)
29001 REM
29002 GOTO 29000
29003 IF MOV$#"O-O" THEN 29000: GOTO 29050
29004 GOTO 29000
29005 IF MOV$(3,3)="-" THEN 29007: IF MOV$(3,3)="X" THEN 29007:
       IF MOV$="O-O-O" THEN 29050: GOTO 29000
29006 IF MOV$(6,6)="+" THEN 29005: IF MOV$(6,6)="*" THEN 29005:
```

in the Apple's memory. Related variables: FL, NL, VFLG.

IX—Index; integer variable used to index into the master array M(2047). It is always a multiple of 64. Related variables: B(63), IM, LOC.

J—Integer work variable.

JJ—Integer work variable.

J3—Integer work variable.

K—Integer work variable.

KK—Integer work variable.

L—Length; integer work variable that will contain the length of the character string MOV$ after move input time.

L1$(25)—Line one; character string constant used in constructing the graphic chessboard.

L2$(25)—Line two; character string constant used in constructing the graphic chessboard.

L3$(25)—Line three; character string constant used in constructing the graphic chessboard.

LL—Integer work variable.

LOC—Location; index to given element of a sub-array in the master array M(2047). Related variables: B(63), F, IX, M(2047), POSM, R.

M(2047—Master array; array variable used in move look-ahead logic and position evaluation. The master array is logically divided into 32 sub-arrays of 64 elements each. A sub-array can be considered to be a separate chessboard owned by a corresponding piece on the playing board B(63). An element in a sub-array will have a nonzero value if (1) the sub-array's corresponding piece occupies the same relative position in the array B(63) or (2) the sub-array's corresponding piece could occupy that same relative position in the array B(63) if there were no intervening pieces. Related variables: B(63), F, IM, IX, LOC, POSM.

**MOV$(15)**—Move input buffer; character string variable which holds the current move for either player. Related variables: A$, B$, V$.

MT—Mate; Boolean variable equal to 1 if the current move has specified checkmate.

MVS(31)—Number of move; array variable which, for a given piece, contains the current number of moves made by that piece. Related variables: B(63), S(31), P, X.

N—Integer work variable.

NF—New from; integer variable used by the program in evaluating all possible positions to move a piece from. Related variables: NS, NT, OF, OS, OT.

NL—Normal video mode; integer constant used to produce normal video output when POKEd at decimal location 50 in the Apple's memory. Related variables: FL, IV, VFLG.

NS—New score; integer variable used in evaluating the strength of a given move in comparison to a previously evaluated move. Related variables: NF, NT, OF, OS, OT.

NT—New to; integer variable used by the program in evaluating all possible positions that a piece may be moved to. Related variables: NF, NS, OF, OS, OT.

O(5)—Obstacles; array variable that will contain positive values equivalent to occupied squares if a piece traverses these squares in a move. Related variables: B(63), T(5).

OF—Old from; integer variable which, when evaluating all possible moves, contains the best current position to move from. Related variables: NF, NS, NT, OS, OT.

OK—Okay; Boolean work variable.

OS—Old score; integer variable that contains the weighing value of the best current move. Related variables: NF, NT, NS, OF, OT.

OT—Old to; integer variable which, when evaluating all possible moves, contains the best current position. Related variables: NF, NS, NT, OF, OS.

P—Position; integer variable used to compute the index X into the arrays MVS(31) and S(31).

PC$(20)—Pieces; string constant that contains the graphic representation for all the chess pieces. Related variables: B(63), FL, IV, NL, VFLG.

POS—Position; integer variable used in the movement of the chess-piece graphics. Related variables: B(63), FL,

```
      IF MOV$(6,6)="=" THEN 29005: IF MOV$="RESIGN" THEN END :
      GOTO 29000
29007 TO=Z:FROM=Z:EPH=Z:EPC=Z:CK=Z
29008 FOR I=Q TO 127 STEP 2: IF MOV$(Q,2)=V$(I,I+Q) THEN FROM=I/
      2+Q: IF MOV$(4,5)=V$(I,I+Q) THEN TO=I/2+Q
29009 IF TO AND FROM THEN 29011: NEXT I: GOTO 29000
29011 TO=TO-Q:FROM=FROM-Q
29012 IF SGN (B(FROM))#H OR SGN (B(TO))=H THEN GOTO 29000: IF B(
      TO) AND B(TO) MOD 10=Z THEN 29000
29013 IF EPA=0 THEN 29015: IF B(FROM) MOD 10# SGN (B(FROM)) THEN
      29015: IF B(TO) THEN 29015: IF EPA#TO THEN 29015
29014 IF L<5 THEN 29015: IF MOV$(3,3)#"X" THEN 29015:I= SGN (B(
      FROM)):EPC=TO+I*8:CP=Q: RETURN
29015 P=FROM: GOSUB 26080: IF M(X*64+TO)#B(FROM) THEN 29000
29016 I= SGN (B(FROM)): IF B(FROM) MOD 10=I AND TO=FROM-(I*16) THEN
      EPH=FROM-(I*8)
29017 GOSUB 25000: IF O THEN 29000
29018 A$(Q)=MOV$(3,3): IF L=5 THEN 29019:B$(Q)=MOV$(6,6): IF B$
      ="=" THEN DR=Q: IF B$="+" THEN CK=Q: IF B$="*" THEN MT=Q
29019 P1= ABS (TO-FROM) MOD 8:P2=B(FROM) MOD 10: IF NOT P1 AND
      P2=H AND B(TO) THEN 29000: IF P1 AND P2=H AND NOT B(TO) THEN
      29000
29020 IF A$="X" THEN CP=Q: IF CP OR NOT B(TO) THEN RETURN : GOTO
      29000
29050 Y=4: IF H>Z THEN Y=28:V=Z: IF H>Z THEN V=24: IF L=3 THEN
      V=V+7: IF MVS(Y) OR MVS(V) OR CK THEN 29000: IF Y>8 THEN
      Y=Y+32: IF V>8 THEN V=V+32
29051 TO=Y:FROM=V: GOSUB 25000: IF O(0) THEN 29000:FROM=Y:CF=V:
       IF L=5 THEN TO=Y-2: IF L=5 THEN CT=V+3: IF L=3 THEN TO=Y+
      2: IF L=3 THEN CT=V-2:CS=1: RETURN
30000 FOR POS=Z TO 63:VFLG=NL: IF B(POS)>Z THEN VFLG=IV: GOSUB
      30010: NEXT POS: POKE 50,NL
30001 FOR POSM=Z TO 15: GOSUB 26000: GOSUB 16000: NEXT POSM: FOR
      POSM=48 TO 63: GOSUB 26000: GOSUB 16000: NEXT POSM: RETURN

30010 VTAB 2*(POS/8+Q): TAB 3*(POS MOD 8)+9
30011 POKE 50,VFLG:J= ABS (B(POS) MOD 100/10)*2+Q: PRINT PC$(J,
      J+Q);: RETURN
31000 TEXT : CALL -936: TAB 8: PRINT L1$
31001 FOR I=Z TO 6: TAB 5: PRINT 8-I;: TAB 8: PRINT L2$: TAB 8:
       PRINT L3$: NEXT I
31002 TAB 5: PRINT Q;: TAB 8: PRINT L2$: TAB 8: PRINT L1$
31003 PRINT : TAB 9: PRINT "A  B  C  D  E  F  G  H"
31004 VTAB 22: PRINT "X BY BLACK"
31005 VTAB 24: PRINT "X BY WHITE";
31006 VTAB 6: TAB 34: PRINT "BLACK";
31007 VTAB 12: TAB 34: PRINT "WHITE";: RETURN
32000 DIM L1$(25),L2$(25),L3$(25),MVS(31),M(2047),WB(3),WW(3),PC$
      (20),B(63),MOV$(15),V$(128),WA(3),WH(3),T(5),O(5),S(31)
32001 L1$=":-------------------------:"
32002 L2$="!  !  !  !  !  !  !  !  !"
32003 L3$="!--+--+--+--+--+--+--+--!"
32004 PC$="  P.QRQNQBQ^K*KBKNKR"
32005 FOR I=Z TO 63:B(I)=Z: NEXT I
32006 B(0)=-25:B(1)=-33:B(2)=-44:B(3)=-59:B(4)=-60:B(5)=-74:B(6
      )=-83:B(7)=-95
32007 FOR I=8 TO 15:B(I)=-11: NEXT I
32008 FOR I=48 TO 55:B(I)=11: NEXT I
32009 B(56)=25:B(57)=33:B(58)=44:B(59)=59:B(60)=60:B(61)=74:B(62
      )=83:B(63)=95
32010 NL=255:IV=63:FL=127:TW=12:TB=TW
32011 V$="A8B8C8D8E8F8G8H8A7B7C7D7E7F7G7H7A6B6C6D6E6F6G6H6A5B5C5D5E5
      F5G5H5"
32012 V$(65)="A4B4C4D4E4F4G4H4A3B3C3D3E3F3G3H3A2B2C2D2E2F2G2H2A1B1C1
      D1E1F1G1H1"
32013 WB(0)=33:WB(1)=7:WB(2)=6:WB(3)=7:WW(0)=33:WW(1)=7:WW(2)=12
      :WW(3)=13
32014 FOR I=Z TO 15:S(I)=I:S(I+16)=I+48: NEXT I: DIM E(15),TK(5
      )
32015 FOR I=Z TO 15:B(I)=B(I)-I*100:B(I+48)=B(I+48)+((I+16)*100
      ): NEXT I
32016 FOR I=Z TO 31:MVS(I)=Z: NEXT I: FOR I=Z TO 15:E(I)=Z: NEXT
      I: RETURN
32766 PRINT 16384-( PEEK (202)+ PEEK (203)*256)+( PEEK (204)+ PEEK
      (205)*256): END
65535 REM (C) 1978 BY LOU HAEHN
>
>
>
>
>
>
>
```

FROM, IV, NL, VFLG.

POSM—Position in master array; integer variable used in updating the sub-arrays in the master array M(2047). Related variables: IX, LOC.

PS—Position score; integer variable used to accumulate weighing points for a given move during move evaluation. Related variables: NS, OS, PSE.

PSE—Position score extra; integer variable used to increase the weighing of a given move. Related variables: NS, OS, PS.

P1—Position scanner 1; integer variable used in position evaluation.

P2—Position scanner 2; integer variable used in position evaluation.

P3—Position scanner 3; integer variable used in position evaluation.

P4—Position scanner 4; integer variable used in position evaluation.

P5—Position scanner 5; integer variable used in position evaluation.

P6—Position scanner 6; integer variable used in position evaluation.

P7—Position scanner 7; integer variable used in position evaluation.

Q—Integer constant equal to 1.

R—Rank; integer variable that represents the rank, or row, of a given position on the board. Values from 0 to 7. Related variables: B(63), POSM, F.

S(31)—Square occupied; array variable which, for a given piece, contains the current square that the piece occupies.

SCK—Save check; Boolean variable that is a temporary hold area for the variable CK.

SF—Save file; integer variable that holds the value of the variable F when F must be modified.

SR—Save rank; integer variable that holds the value of the variable R when R must be modified.

SVT—Save to; integer variable that holds the value of the variable TO when TO must be changed.

T(5)—Traverse; array variable whose elements describe the squares traversed when a piece is moved two or more squares. Not applicable if the piece to be moved is a knight or a pawn.

TB—Tab black; integer variable that indicates the next open position in black's capture list.

TF—To file; integer variable that represents the file, or column, from which a piece is to be moved. Values are from 0 to 7. Related variables: B(63), F, TO.

TK(5)—Traverse king; array variable whose elements describe the squares traversed between the program's king and the piece that has just put the program into check. Related variable: T(5).

TO—Integer variable equivalent to the square to which a piece is to be moved. Related variables: B(63), FROM, TF, TR.

TR—To rank; integer variable that represents the rank, or row, to which a piece is to be moved. Values are from 0 to 7. Related variables: B, R, TO.

TW—Tab white; integer variable that indicates the next open position in white's capture list.

V—Integer work variable.

V$(128)—Valid moves; string constant that contains all valid moves in algebraic chess notation.

VFLG—Video mode flag; integer variable used to set the current video display mode. Related variables: FL, IV, NL.

WA(3)—Window for Apple; array variable used to generate a text window for displaying the program's moves.

WB(3)—Window for black; array constant used to set either WA(3) or WH(3) to the constants needed for displaying black's moves.

WH(3)—Window for human; array variable used to generate a text window for displaying the human player's moves.

WW(3)—Window for white; array constant used to set either WA(3) or WH(3) to the constants needed for displaying white's moves.

X—Index; integer variable used to index into the arrays MVS(31) and S(31).

Y—Integer work variable.

Z—Zero; integer constant equal to 0.■

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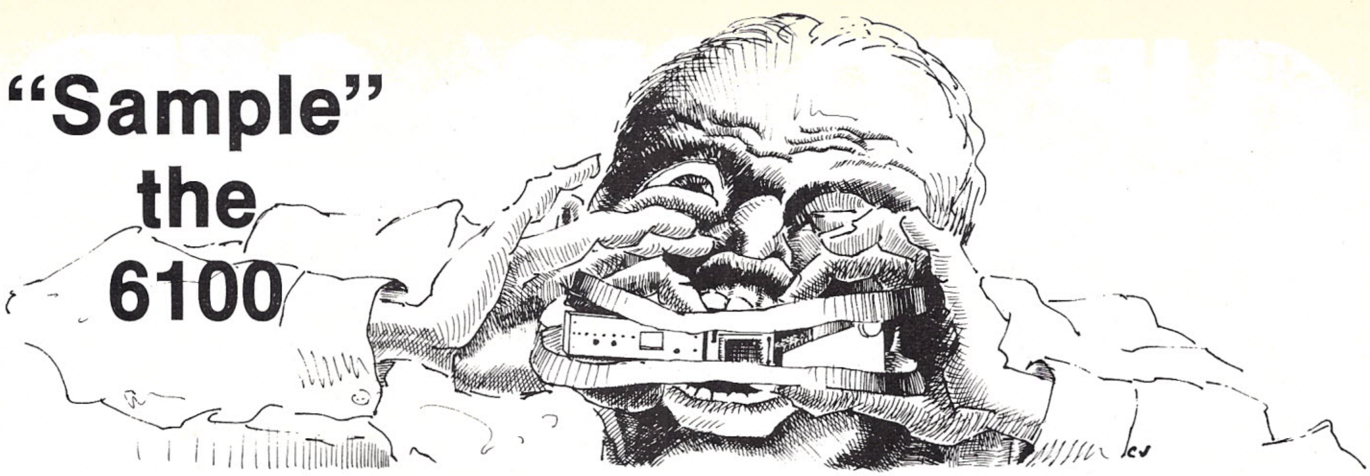
"Sample" the 6100



James Downey
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Mobile AL 36680

Most of the attention of the ever-growing body of microcomputer enthusiasts has been concentrated on a mere handful of processors. One that has generally been overlooked to date is the Intersil/Harris 6100. Why experimenters have looked elsewhere for that ideal chip set is not entirely clear. They may have heard that the 6100 has an antiquated instruction set. Perhaps they were wary of the 12-bit word length or felt uncomfortable with CMOS technology.

I suspect, however, that the greatest reason is simply a lack of company. To put together a system from scratch is a formidable undertaking. Furthermore, by computer industry standards, the financial investment in a microprocessor system may be minuscule, but by most hobby standards it is still enough to make most of us wince. Needless to say, few will embark on such a project unless they are assured of a favorable outcome.

Pro 6100

Why, then, if the 6100 is so poorly represented in the personal computer world, should anyone even consider it? Far and above, the main reason is the PDP-8[1] instruction set. Digital Equipment's sales of these minis over the past decade or so compare favorably to McDonald's volume in hamburger sales.

Due to the immense popularity of that machine in the industry, a great deal of PDP-8 code has been written and is very much available, not at the corner electronic store, however, but primarily through Digital Equipment's software distribution centers, where assemblers, editors and high-level languages are available for very reasonable prices. It's also available through the worldwide Decus Society, where hundreds of PDP-8 programs are available with documentation for only a minimum charge, usually $2 for paper tape.

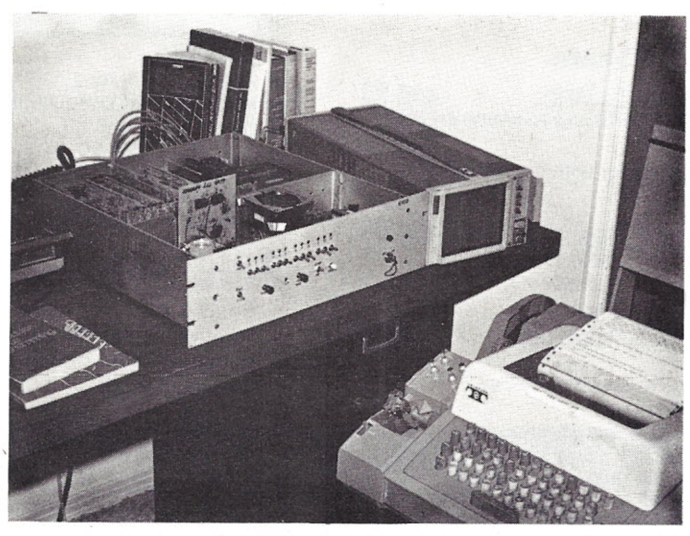
Another plus not to be overlooked is that you may have had previous PDP-8 experience. Most who have had a close encounter of some kind with one of these creatures find them quite friendly and, at one time or another, usually fantasize about having one for their very own. And, after all, if you are comfortable in one language, why learn another?

Finally, there are those among us who just like to do things a little differently than the next guy. The all-CMOS 6100 is indeed something different and is guaranteed to raise eyebrows when you show up at a club meeting with it.

Construction

By far, the best way to scratch-build the 6100 system is to purchase the CMOS sampler package[2] manufactured by Intersil. At $49, it includes a CPU chip, 256 words of CMOS RAM, a ROM containing an excellent keyboard monitor, an interface chip, a UART and a baud rate generator. It includes excellent manuals that are sufficient to get even the greenest of beginners up and running.

Software operation of the ROM-based monitor is covered in detail by the sampler manual, and a commented listing of the ROM's contents is provided. In addition, the sampler manual gives several interface options for the serial terminal and shows how to implement some handy front-panel options such as hardware single step and data displays.



The author's 6100 system featuring 4K of RAM, two channels of D/A, eight channels of A/D and a real-time clock.

I built my original system with wire-wrap construction on a general-purpose Augat board. I have also built the sampler system on perfboard with glued-in sockets, and the results were the same. For under $40, a high-quality board, the 6960 sampler board, which will accommodate the sampler chip set, is available from Intersil. The board includes: status indicators, hardware single-step control and a serial interface. The perfboard is the cheapest and the Intersil board is the slickest, so take your choice; they all work.

For my system, I gutted a surplus power supply for the 19 inch chassis and salvaged a strip of 30 pin connectors (originally part of a computer backplane), which I use for an expansion bus. A good choice for a bus would be the common 44 pin edge connectors. These accept the 4 1/2 inch × 5 inch cards and are readily available. Due to the 12-bit word length and the common address/data bus, the system does not lend itself well to the popular S-100 configuration. My experience with the system is that it is quite noise tolerant, and about any layout will work.

One construction consideration you should observe, however, is to keep heat-generating devices such as regulators, Tristate buffers or non-CMOS

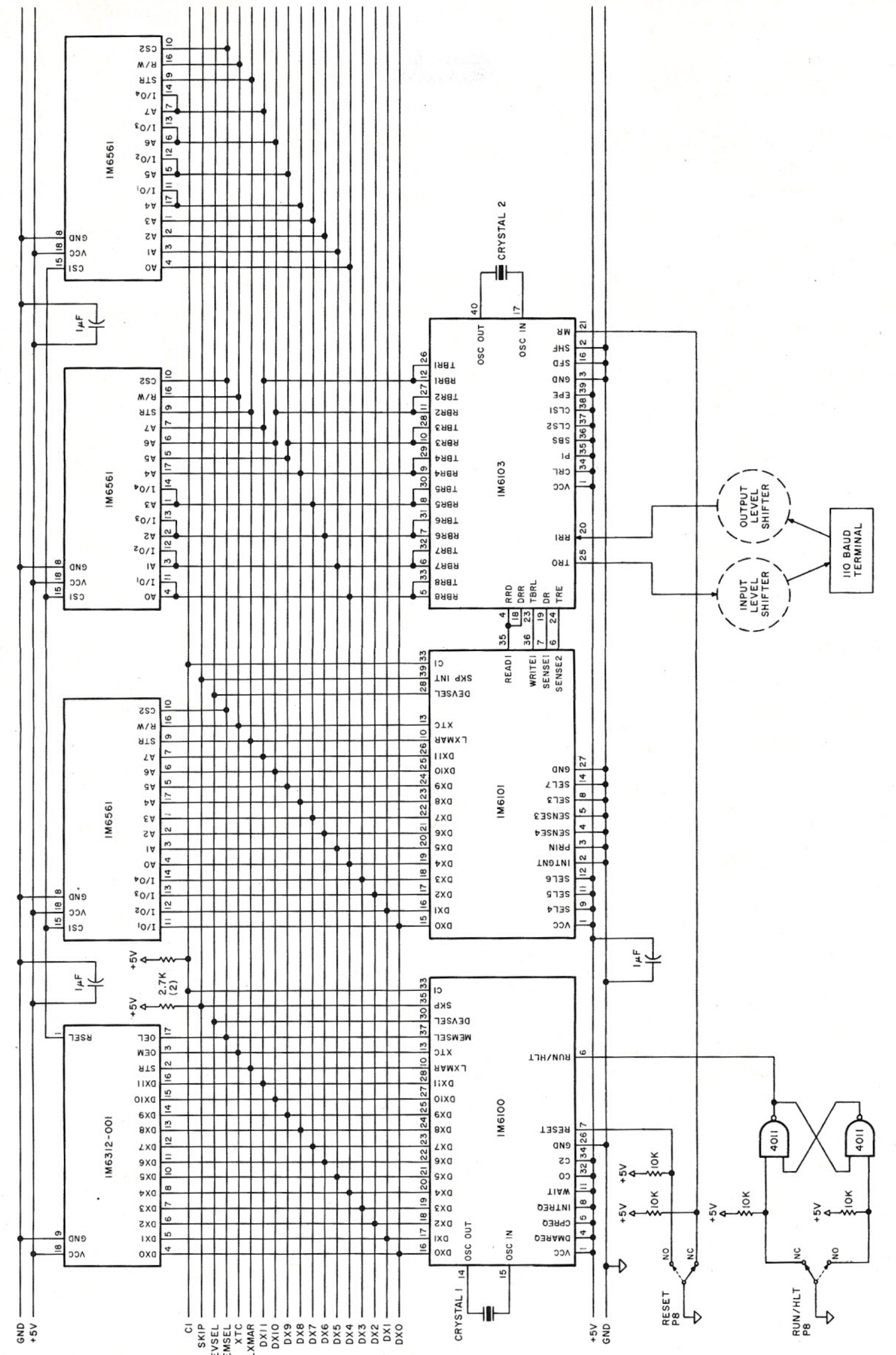


Fig. 1. The system schematic for the 6100 sampler system. Note the single DX bus replacing the traditional data and address buses.

RAM away from the LSI CMOS chips. Unlike other microprocessors, they are cool-running and seem to require it that way.

Fig. 1 shows the sampler system interconnections. Notice that the address and data lines are not separate. Everything is time-multiplexed on one set of bidirectional DX lines. This immediately eliminates 12 lines from the bus as compared to that used on most micros. This is why 30 lines in my bus are more than adequate. The ROM is similar to Motorola's MIKBUG in that it is Teletype-oriented. The ROM includes a binary formatted paper-tape punch and load routine, so an ASR 33 or equivalent is the only sensible way to go with this system.

An inexpensive cassette interface for the 6100 system is available ($25 from The Bit Stop, Box 973, Mobile AL 36680), but its software is currently not available on ROM; you must still use paper tape to initialize the system. The ROM features an emulation of Digital's popular octal debugging technique and is first-rate as a keyboard monitor.

Options

The CMOS sampler manual shows how to enable several panel options, some of which I incorporated on my system but really are not necessary. One option not covered by the manual but highly recommended is the switch register. When the machine executes a 7404_8 instruction (OR the switch register), the settings on the 12 panel switches are logically ORed into the accumulator. This is by far the easiest way to communicate with the machine, since only one instruction is required to bring in a 12-bit word versus a fairly large amount of code required to do this from the keyboard.

More important, much of Digital's software employs this instruction making the switch register a prerequisite for any user who anticipates using those packages. Fig. 2 shows how the data from the switch register is strobed onto the DX lines with Tri-state buffers.

The sampler package includes 256 words of CMOS memory. You will be amazed at what you can do with this limited space, but soon you will get the urge to increase memory size. For my system, I considered Intersil's CMOS memory too expensive—about $85/K—and used the cheaper static RAM as shown in Fig. 3.

PDP-8	Sampler	Operation
6036*	6160	Read one character
6031	6162	Skip when character received
6046	6161	Transmit one character
6041	6163	Skip when transmit done
NA	6166	Start reader
NA	6167	Stop reader

*6036 also advances the reader one character automatically; 6160 does not.

Table 1. Comparison to Teletype instructions between the 6100 sampler system and Digital Equipment's PDP-8. In general, simply substituting corresponding code from the sampler column for code in the PDP-8 column is all that's needed to configure a PDP-8 program for the 6100. A word search routine is present in the sampler ROM making it easy to find the offending code.

I used 2114 chips, which are 1K by 4, running about $36/K. The 1K × 1 21L02s could be used to lower the price to around $24/K, but because of the 12-bit-wide word, this means a lot of wiring. The 2114 layout puts 2K on a board, and these chips will easily fit on a 4 1/2 × 5 experimenter card.

The 12-bit address structure of the 6100 only allows for 4K of addressable memory (this can be expanded to 32K using the Intersil 6102 memory expansion chip), and I have, therefore, limited my system to 4K for the time being.

The fourth K of memory is occupied by the ROM. Though Digital's assembler and editor will run in 3K of memory, FOCAL, BASIC and the 23-bit floating-point package require the full 4K. I therefore put a fourth K of RAM opposite the ROM card and simply put a toggle switch on the chip select line (MEMSEL) to select from one to the other. Working in the fourth K of RAM is a little tricky, since the keyboard monitor must be deactivated, but it's nothing a little creative programming can't get around.

The simplest solution is to load Digital's ODT Low, a Teletype-oriented monitor that occupies about 375 locations in low memory, execute ODT and throw the RAM/ROM switch . . . and "presto," you have a PDP-8 just like the real thing. If your program doesn't use the fourth K, then the ROM ODT is that much handier, since it can't accidentally be wiped out.

By the way, you need not populate the entire 4K all at once. Just one K makes a fine starter system if only part of the memory is populated; however, be sure some memory resides in location $0\text{-}200_8$, since the ROM uses this as its scratchpad.

Other useful options included in the sampler manual include an LED on the run/halt line. This allows the user to tell at a glance if the processor is in a halt state. I also added Tri-state buffers to the lines exiting the CPU as shown in the 6100 manual that accompanies the sampler kit.

If you are sure you will stay with a simple 4K system and an ASCII terminal, you can eliminate the buffers and run the CPU barefoot right into the DX lines. However, let me warn you, the system is extremely simple to interface through the 6101 PIE chip, and it probably won't be long before you hang enough peripherals on it to exceed the capacity of the bus. I, therefore, recommend that the buffers be incorporated early in the design.

On my system, I currently have eight channels of A to D, two channels of D to A, a cassette interface and a real-time clock running. Remember, with memory extension hardware, another 4K of memory

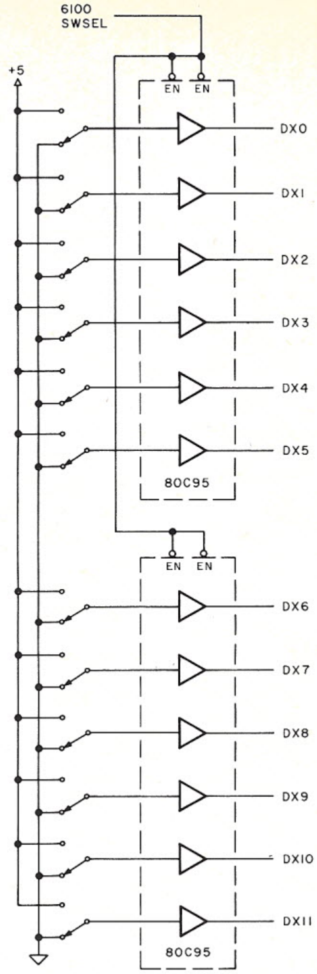


Fig. 2. Hardware required to implement the or-the-switch-register instruction (OSR). Much of Digital Equipment's software uses the switch register. Also, it's the easiest way to put a 12-bit word into the system, since only one instruction is required.

and a floppy disk, the system could accept the capable OS/8 software with two levels of FORTRAN, BASIC and a host of other goodies, so don't think too small at this stage.

For power I have 2.5 Amps at 5 volts. Though the CMOS system draws negligible current, the 4K of RAM will draw about an Amp. With the Tri-state buffers and some LED displays, this adds another half of an Amp or so. A tenth of an Amp of −12 is also needed for the Teletype interface.

The sampler manual claims the commercial grade chips will perform well at a clock frequency of 3.5 megahertz (a color TV crystal); however, I encountered some problems with the UART at this speed, and it

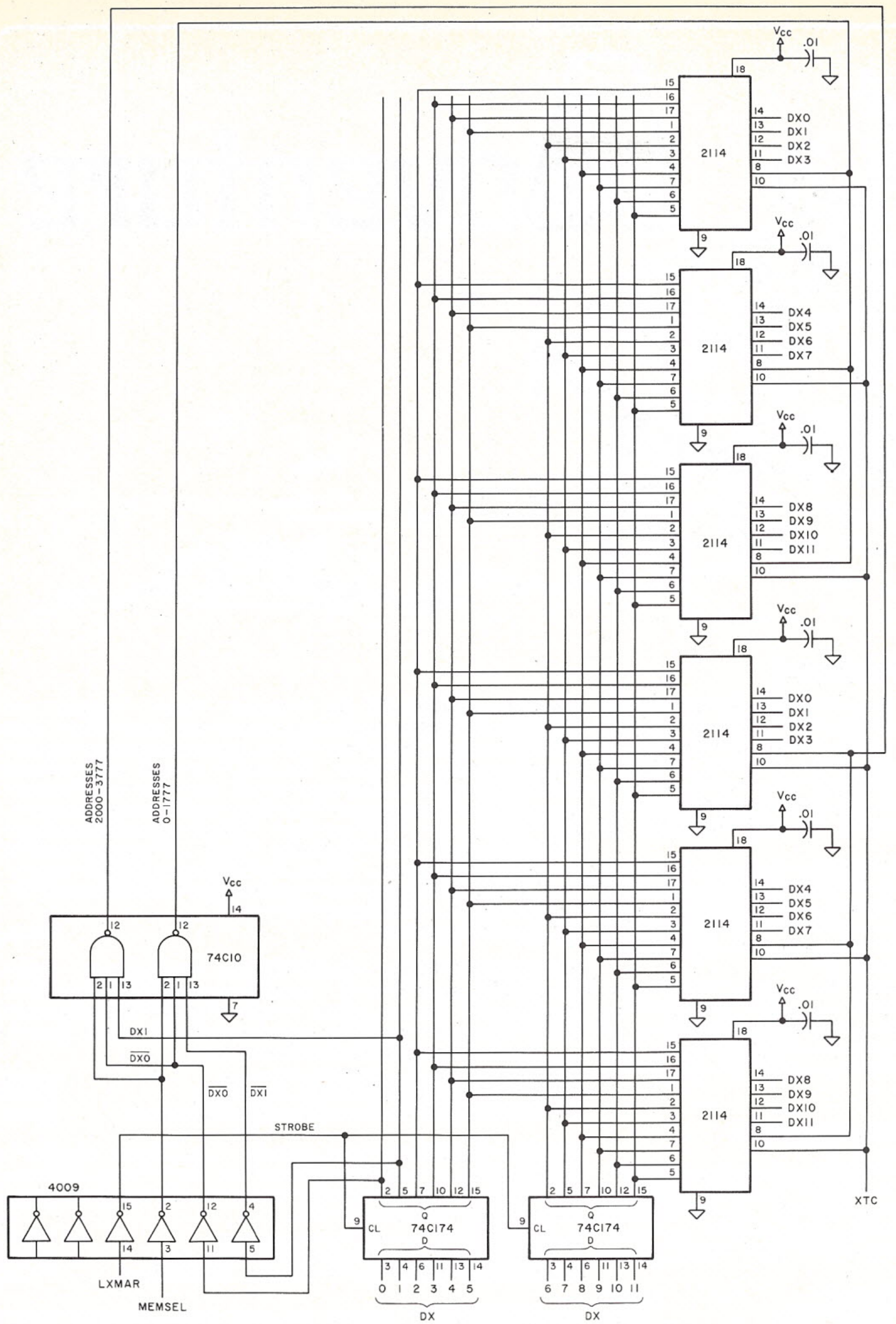


Fig. 3. Static RAMs are easily interfaced to the 6100. Notice how the two most significant bits, 0 and 1, are used to select each K of memory. Addresses are latched off the DX lines using LXMAR as a strobe.

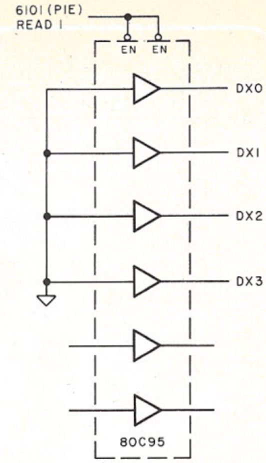


Fig. 4. Hardware to force DX lines 0-3 to a logic zero while reading from the terminal. This modification eliminates the need to mask out these bits in the program, making the system more compatible with Digital Equipment's software.

also puts the 2114 memory chips slightly under their specified access time of 450 ns, though they seemed to work. When I substituted a 2 MHz crystal, all of these problems disappeared; yet the loss of processor speed was not really noticed. Later sampler kits have included a notice to this effect.

Software Compatibility

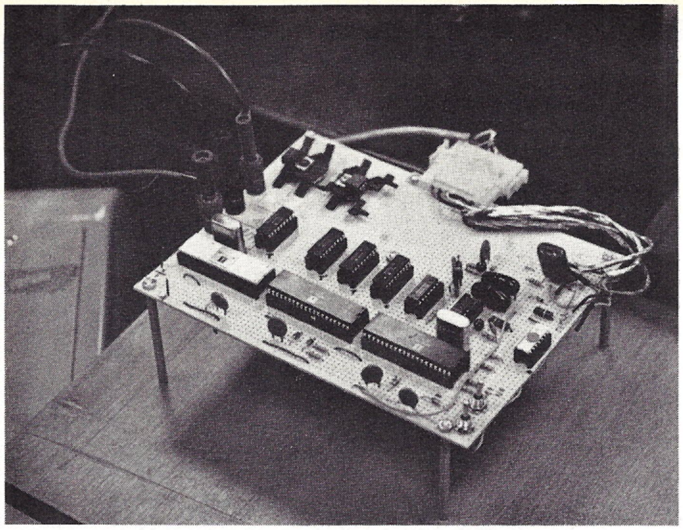
The I/O is very similar to the PDP-8; however, there are some differences, and patches will have to be made to PDP-8 software to make it compatible. A true PDP-8 interface can be built, but it is complex and, in my opinion, it is far easier to simply make the patches. Basically, these differences in I/O are shown in Table 1.

The ROM and ODT both employ a word search feature, so it is easy to locate the offending code and replace it. To enhance software compatibility, it is prudent to make the 6100's I/O as similar to the PDP-8's as possible. Notice in Fig. 1 that data read by the UART is deposited on the DX lines 4-11. Eight lines are used, since the Teletype sends 8-bit ASCII. DX lines 0-3 are unwired and will contain garbage. To get rid of the extraneous garbage, it is necessary to mask out bits 0-3 after each read in the software.

This added maneuver is often hard to squeeze into a tight PDP-8 program. By forcing these lines to zeros, however, with a Tri-state buffer as shown in Fig. 4, the garbage bits and the mask operation are eliminated, making the interfaces almost identical in structure.

Software availability is primarily through the Digital Equipment software distribution center in Maynard MA. The best way to obtain software, however, is to find a PDP-8 in the field and go through its box of goodies. They are widespread and not too hard to find.

Every PDP-8 leaves the factory with a tray of tapes including an editor, an assembler, a great floating-point arithmetic package and a copy of 4K FOCAL. A good place to start looking for an 8 is a local college or university. The best gold mine for software is the Decus Society; however, membership is limited to users of Digital Equipment's machines.



A minimal system configuration for the sampler kit. Built on perfboard, this system can easily be constructed for under $100.

So, when you find a PDP-8 (or a PDP-12 that is language compatible), ask its users about Decus. Also, ask them about licensing agreements, since some of Digital Equipment's software is protected by licenses. A listing of patches and a description of special operating procedures required to run the basic Digital Equipment software kit, including FOCAL, on the 6100 is available for $5 from The Bit Stop, Box 973, Mobile AL.

Finally, an excellent manual, *Introduction to Programming*, tells all about programming the 6100. It is available from Digital Equipment Corporation for $5 and is a must for the serious 6100 user.

In summary, I have found the 6100 system, as supplied in the CMOS sampler kit, an economical and easy system to build. The result is a reliable PDP-8 processor. That Digital is currently using the 6100 system in their new DEC-station version of the PDP-8 attests to this fact. When you add the software availability, the 6100 makes a fine system for the scratch-builder. ■

[1]PDP-8 is a registered trademark of Digital Equipment Corporation, 129 Parker Street, Maynard MA 01754.

[2]Intersil part number 6801, available through Schwebber Electronics, Atlanta GA.

An Inexpensive and Easy EPROM Board

SWTP owners can add EPROM with a minimum of hassle using a bare 4K RAM board.

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Pittsburg State University
Pittsburg KS 66762

After purchasing a disk for my SWTP 6800 computer, I found that waiting for the disk bootstrap to load and putting up with the cassette recorder/AC-30 were more than I wanted to live with. The answer was a ROM board. The supply of available boards sell at incredible prices. The solution: Utilize a spare, bare SWTP MP-MB (4K memory) circuit board and build a piggyback EPROM circuit board.

The use of 2708 EPROMs with the board designed for 2102s greatly simplifies the project. Both memories have the same address lines available. The only difficulty comes in the necessity for a −5 and +12 volt power supply. Using three-terminal regulators and the ±14 volts available on the bus easily solves the problem.

The EPROM board is wired to the 4K board utilizing the original address and data buffers, and the chip enables for the first and second K of the 4K board. If the 4K board is addressed to begin at C000, the EPROMs will be addressed beginning at C000 and C400, respectively. The remaining 2K may be populated with 2102s as originally designed. This 2K would be addressed beginning at C800. A schematic is shown in Fig. 1.

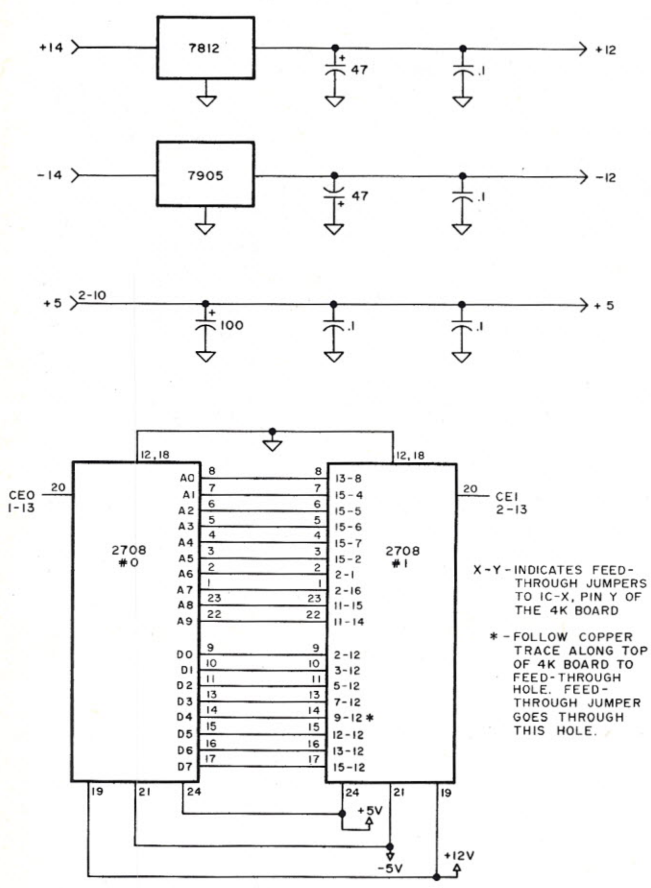


Fig. 1.

Construction

As may be expected, once the circuit board is obtained, construction is relatively easy. First, you have to install the three-terminal regulators, capacitors, jumpers and EPROM sockets on the EPROM piggyback board. Be *very* sure that *all components are soldered with good solder joints and that there are no solder bridges.*

Next, insert the parts on the 4K board, with the exception of the first 2K of 2102s and the two capacitors (C1 and C2), according to SWTP instructions. The EPROM board will cover these portions of the 4K boards. I recommend the installation of sockets for all integrated circuits (especially the 2102s). Do not install 2102s at this time.

The next step in construction is to install, on the EPROM board, the wires to run between the EPROM and the holes on the original 4K board. These points are marked on the component layout (Fig. 2) by circles around the holes. Note that one jumper on the EPROM board also goes through a circle and to the 4K board. These feedthrough jumpers are also indicated on the schematic with an indication of the integrated circuit and pin number the jumper connects to on the 4K board. These between-board jumpers should be stagger-cut to simplify the problem of lining up the jumpers with their proper holes on the 4K board.

Finally in preparation, two insulated wires must be soldered to the EPROM board to be run later to the +14 and −14 volt pins on the bus connector. Check again to be sure that all connections are well soldered, and that there are no bridges. After the two boards are joined, the copper side of the EPROM board is no longer accessible.

Insert the interconnecting jumpers into the proper holes in the 4K board, and carefully push the EPROM board toward the 4K board. The EPROM board should be within about .1 inch of the 4K board. This will prevent problems with adjacent boards when it is installed in the computer. Carefully solder the interconnecting jumpers to

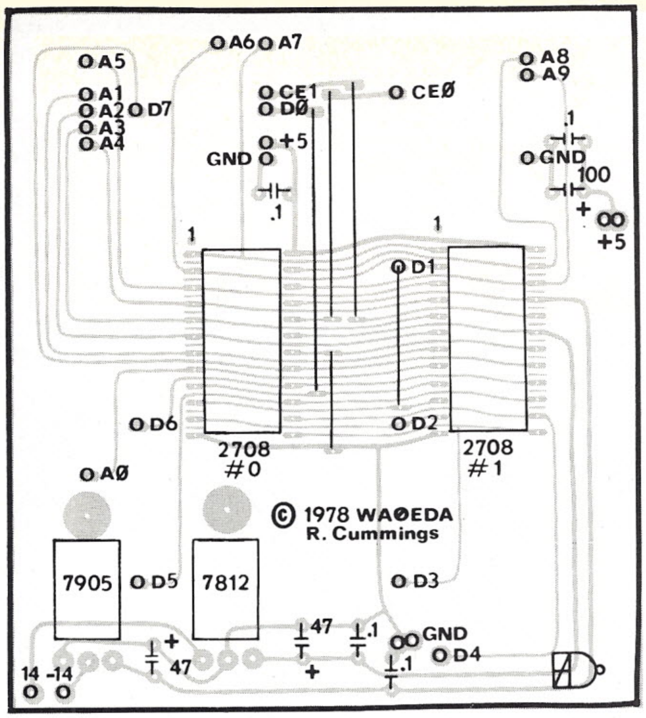


Fig. 2. Example of component layout overlay (circles represent between-board jumpers).

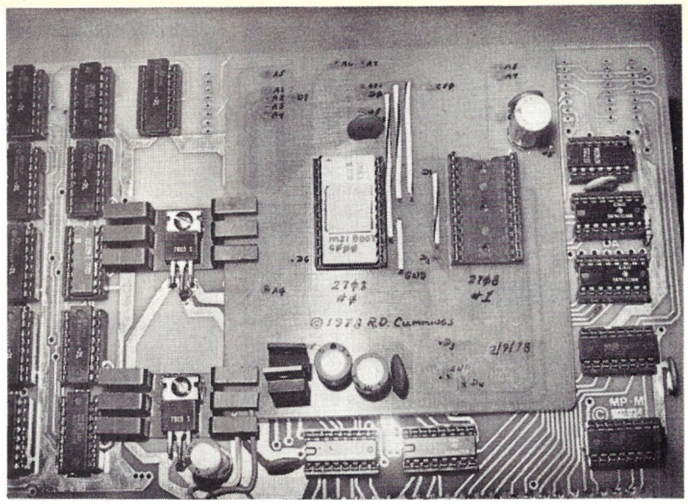
the 4K board. If too much heat is used, the solder of the EPROM board will melt and the interconnecting jumper may no longer make contact. Connect the wire from the +14 pad of the piggyback board to pin 19 of the bus connector and the −14 pad of the piggyback board to pin 20 of the bus connector.

Checkout

This completes construction of the EPROM/RAM card. The card can be checked out as usual without the MOS integrated circuits installed to be sure the voltages are correct. Next, install the 2102s into the top 2K sockets and check them with memory diagnostics. When everything checks out to this point, a 2708 may be installed and its program checked. After these checks, this board is ready for use.

Summary

A close-up of the completed prototype board is shown in the photo. Operation of this board is just like that of a RAM card with the first 2K protected. The prime 2708s have a 450 ns access time and, therefore, no slowdown techniques are necessary. If the card is addressed at C0, and the SWTP SWTBUG operating system is used, the first EPROM is jumped to directly simply by typing a "Z" on the keyboard. The documentation with the A2 CPU board gives any easy method of addressing the 4K board to the top 32K positions.



Close-up of prototype board. *(Photo by Keving Pursley)*

This was the most cost-effective method of getting an EPROM circuit board for my computer. The 4K unpopulated boards are available from SWTP, as are the bus connectors. The other required parts are available from advertisers in the back of this magazine. Since 2708s are available for about $10 now, the whole board, less 2102s, but including one EPROM, can be built for about $55. The EPROM piggyback board can be purchased from K. Pursley, PO Box 143, Pittsburg KS 66762.

As a final reminder, I want to once again recommend that you check carefully to be sure that there are no problems on the EPROM board before you attach it to the 4K board, and be very careful soldering the interconnecting jumpers to the 4K board. ■

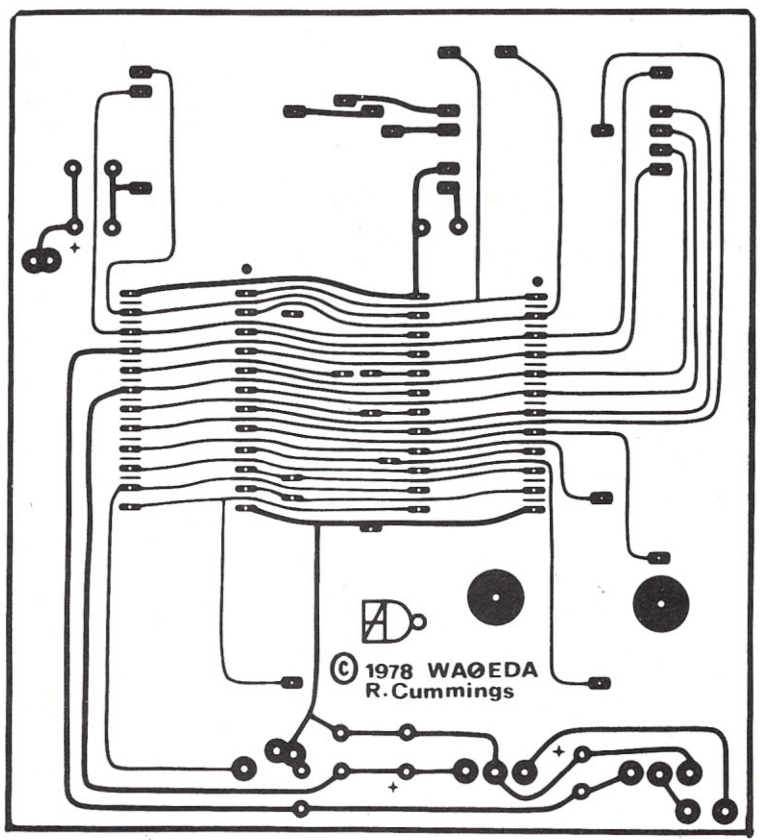


Fig. 3.

✔ Reader Service—see page 227

One day my winking cursor was PEEKing while up and running in a straightforward single-step mode via my sophisticated bells and whistles, when suddenly—I jumpered my POKE into the bus and ORed my powerful handshaking capability, which resulted in a trade-off . . . then commenced PEEKing into the mainframe and discovered that the motherboard was interfacing via the 22-pin cushion; this resulted in ANDing and/or ORing the BASIC (no pun intended) computering facility of the SASE and IEEE, which horrified the harmonics and

Eschew Obfuscation

the computer widow, the latter of whom divorced me and went off and running with the local users' group of bit bangers, who all wished her good luck and happy computing. . . . .

If your brain has been buzzed by buzzwords, here are some English translations.

Allen Watson III
430 Lakeview Way
Redwood City CA 94062

Now that microcomputers are making computing affordable, many people are involved with computing for the first time. These newcomers to the field often have trouble understanding the specialized language that is used in most of the books and periodicals that deal with computing. To make it easier for them to learn this new vocabulary, here is a glossary that provides equivalent expressions in ordinary English for many of the computer buzzwords that cause trouble for neophyte computerists.

Altair Bus: interstellar mass transit.
Assembler: a person who puts computer kits together.
Back Plane: all the interesting stuff is on the front.
Baud: a denizen of a baudy house.
Bed of Nails: place where a test programmer sleeps.
Bells and whistles: trinkets for the computer.
Binary: a consumer-protest slogan.
Bus: a mass-transit vehicle.
Buss: a short period of osculation.
Bytes: what a vampyre does.
Card Reader: a fortune-teller.
Checksum: what's left is your bank balance.
Clock Interrupt: what wakes you up on weekdays.
Comm Link: associating with a fellow traveler. See Pinko.
Conditional Branch: a dowsing rod.
Cycle Stealing: petty larceny.
Cyclic Redundancy Check: taking inventory in a bike shop.
Debugging: infinite regression.
Disassembler: as distinct from dose assemblers. See Assembler.
Floppy Disk: lower back trouble.
Flowcharts: maps used by riverboat pilots.
Full Duplex: e.g., a cocktail party.
Fully Integrated: see busing.
Half Duplex: a small apartment.
Handshaking: state of the user the first time he tries out the computer.
Hardware: e.g., helmet, gauntlets, cuirass, greaves, etc.
Hex: to cast a spell.
Hidden Refresh: keeping the flask in the desk drawer.
High-Level Language: spoken at summit meetings.
Immediate: the need for a new compiler, disk drive, etc.
Indirect Addressing: confidential mail forwarding.
Interface: Vhere ve heil der Fuehrer.
Interpreter: worker at the UN.
Low-order Bits: random numbers in base 2.
Memory Refresh: souvenirs.
Monitor: See Merrimack.
Motherboard: See Soap Opera.
Negative Logic: reverse psychology.
Os: a mythical country.
Packing Density: See Full Duplex.
Parameters: what you use to measure two things at the same time.
Parity Bit: having two guests at 4 PM.
Personal Computing: kinky computer dating service.
Program Counter: a user group's software librarian.
PROM: a social event for adolescents.
RAM: a Los Angeles football player.
Random Access Storage: e.g., an attic.
Rectifier: the result of a collision with a gasoline truck.
Regulator: e.g., prunes.

Masked ROM.

ROM: a gypsy man.
Scan: a garbage receptacle.
Sign Bit: the act of paying by credit card.
Software: polyester doubleknit.
State of the Art: New York
Straightforward: basketball player who doesn't bore you to death with details of his alternative "life-style," or get busted for cocaine possession.
Subroutine: U-boat SOP.
Two's Complement: a small mutual-admiration society.
Up and running: computerized candidates.
Utility: e.g., water, gas, electricity.
Write Enable: a smooth, flat, solid surface.

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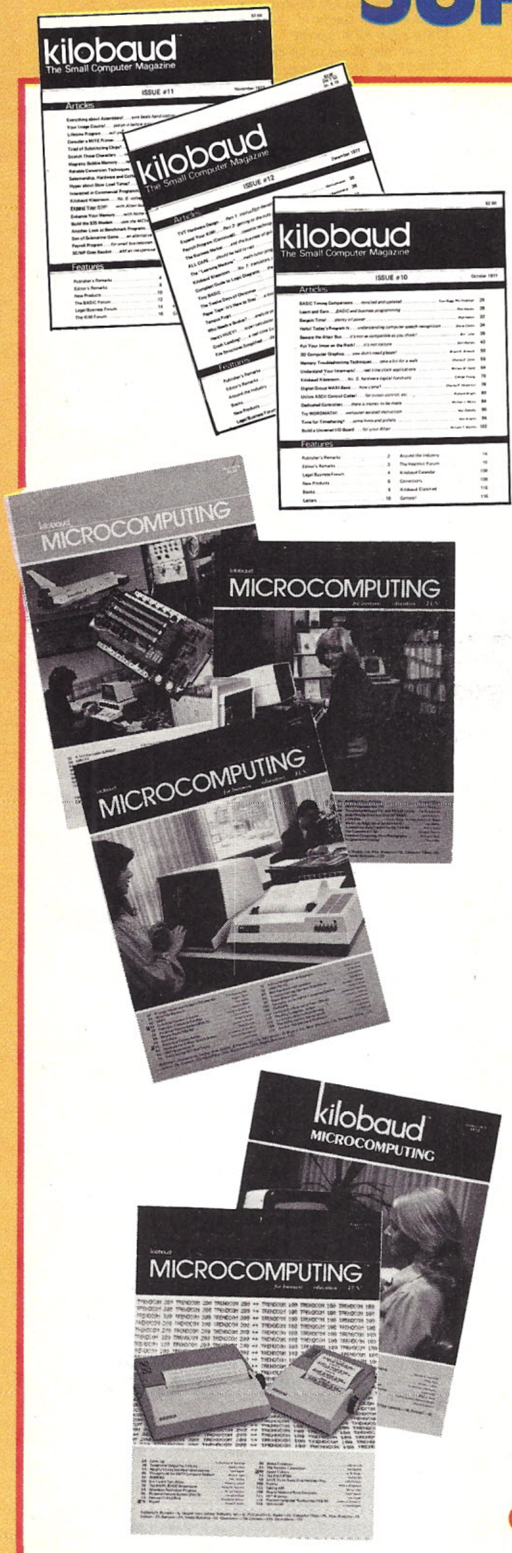

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☐Bridging the Gap . . . *tips on turning an application into a program*
☐Adding "Plop" to Your System . . . *a noisemaker for computer games*
☐Lunar Lander
☐Silence Noisy Teletype Motors . . . *Part 1: Getting the Ball Rolling*
☐A Home Computer Pioneer . . . *profile of Don Tarbell*

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☐Build Your Own Interface
☐Computer Club Promotional Techniques
☐Artillery Practice
☐Put a Micro in Your School
☐Torpedoes Away!
☐Build a Pulse Generator
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☐The BYTEDESTROYER . . . *review of an EPROM eraser*
☐BASIC Timing Comparisons
☐Solving Keyboard Interface Problems
☐A Clean Cassette
☐Try a Design Console . . . *for practical hardware prototyping*
☐Try Solar Energy
☐Simplified Billing System . . . *in BASIC for the small business*
☐Kilobaud Klassroom . . . *No. 2: Gates and Flip-flops Explained*
☐Computerized Typesetting . . . *an introduction to word processing*
☐Introducing! The World's Cheapest Computer . . . *a $60 SC/MP*
☐My Friend is a Computer Junkie

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☐Inside the Sphere Microcontroller
☐The Great TV to CRT Monitor Conversion
☐Computer Turns Director . . . *an interview with filmmaker John Whitney*
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☐Cassette Interface First Aid . . . *use your processor to set timing*
☐Understand Your Computer's Language
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☐Inside the Amazing ASR 33 . . . *checking out the most popular terminal*
☐Try Computer Composition

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☐Expand Your SWTP 6800 . . . *with a new 8K board*
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☐Understand Your Computer's Language . . . *Part 2: Instruction Sets*
☐Enter the Audible Computer!
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☐SWTP 4K BASIC Notes . . . *implementing it on the 680b*
☐Hexdec . . . *hexadecimal to decimal conversion*
☐Start a One-Man Computer Club
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☐Cure that Hot Power Supply

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☐Build Your Own ASCII Keyboard . . . *with serial and parallel output*
☐The Ultimate Personal Computer
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☐A PET For Every Home . . . *a look at the Commodore PET 2001*
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☐Try an 8080 Simulator
☐Build a $20 EPROM Programmer . . . *for the 5402 4K chip*
☐Faster MIKBUG Load Technique . . . *uses binary format*
☐Decoding Device Control Codes . . . *uses a UART, naturally*
☐Tarbell Asynchronous Format
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☐Using an Invisible PROM . . . *how to relocate monitor programs*
☐Klingon Capture Game
☐Starting a Business?

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☐BASIC Timing Comparisons
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☐Hello! Today's Program Is . . . *understanding computer speech recognition*
☐Beware the Altair Bus
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☐Everything about Assemblers! . . . *sure beats hand-coding*
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☐Lifetime Program
☐Consider a MITE Printer . . . *alternative to the ASR-33*
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☐Stretch Those Characters . . . *mods for the SWTP PR-40*
☐Magnetic Bubble Memory
☐Reliable Conversion Techniques
☐Salesmanship, Hardware and Coffee
☐Hyper about Slow Load Times? . . . *KIM Hypertape is an alternative*
☐Interested in Commercial Programming?
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☐Expand Your KIM! . . . *with Altair bus devices*
☐Enhance Your Memory . . . *with home information retrieval*
☐Build the $35 Modem . . . *uses the MC14412 and a UART*
☐Another Look at Benchmark Program
☐Son of Submarine Game
☐Payroll Program . . . *for small businessmen*
☐SC/MP Goes Baudot . . . *add an inexpensive TTY*

December 1977

☐TVT Hardware Design . . . *Part 1: instruction decoder and scan*
☐Expand Your KIM! . . . *Part 2: getting to the nuts and bolts*
☐Payroll Program (Continued) . . . *cassette techniques*
☐The Business Market
☐ALL CAPS
☐The "Learning Machine" . . . *math tutor program*
☐Kilobaud Klassroom . . . *No. 7: transistors, diodes and op amps*
☐Compleat Guide to Logic Diagrams
☐Tiny BASIC
☐The Twelve Days of Christmas
☐Paper Tape: It's Here to Stay . . . *a look at the OP-80A*
☐Tempus Fugit
☐Who Needs a Broker?
☐Here's HUEY! . . . *super calculator for the 6502*
☐Crash Landing! . . . *a real-time Lunar Lander game*
☐File Structures Simplified

kilobaud microcomputing

articles you may have missed during '78 & '79

January 1978*

February 1978

- ☐ **Biorhythms with Your KIM**
- ☐ **Vandenberg Data Products 16K Board Reviewed**
- ☐ **Inventory, Accounts and Reports**
- ☐ **Small Business Software** . . . *Part 1: accounts receivable*
- ☐ **The Music Man**
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- ☐ **Hot-Rod Mods for Your SWTP System**
- ☐ **Tickled by Fickled** . . . *a charting and diagramming aid*
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- ☐ **Expand Your KIM!** . . . *Part 3: bus control board and memory*
- ☐ **Interfacing Tips**
- ☐ **Kilobaud Klassroom** . . . *No. 9: Counters and Registers*
- ☐ **Teaching Preschoolers Letter Discrimination**
- ☐ **Why Structured Programming?**
- ☐ **Source Listing the Hard Way**
- ☐ **How Good Is Tarbell's Floppy Interface?**
- ☐ **Manipulating ASCII Data**
- ☐ **Read any Good Books Lately?** . . . *a program to test readability*
- ☐ **George Morrow's Versatile Front-Panel Board**
- ☐ **Deflection!** . . . *a video game for the quick and agile*
- ☐ **How Much Memory for a KIM?**

March 1978

- ☐ **Build the "Simple Computer"** . . . *a home-brew 8080*
- ☐ **Hardware Program Relocation, Part 2**
- ☐ **State Capitals**
- ☐ **Customized MIKBUG**
- ☐ **TV Typewriter Update**
- ☐ **Foolproof Cassette Operation**
- ☐ **Number-Crunching Time**
- ☐ **Super Terminal!** . . . *interfacing the Burroughs 9350-2*
- ☐ **Consumer Computer, Inc.**
- ☐ **Programmed Instruction Made Easy: Tiny PILOT, Part 1**
- ☐ **Protect Your Memory Against Power Failure**
- ☐ **Backup Techniques** . . . *how fail-safe is your system?*
- ☐ **Small Business Software, Part 2**
- ☐ **Expand Your KIM!** . . . *Part 4: a TTY substitute*
- ☐ **Faster Erase Times** . . . *build a quicker EPROM eraser*
- ☐ **I/O Programming for the Altair Disks**
- ☐ **The Axiom EX-800**
- ☐ **Tiger Trouble!** . . . *TI programmable-calculator safari*
- ☐ **Temperature Sensing**
- ☐ **A Different Approach to HI-LO**

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- ☐ **Taming the I/O Selectric** . . . *Part 1: hardware interface*
- ☐ **Home-Brew Z-80 System** . . . *Part 1: front-panel construction*
- ☐ **A Strategy for Healthy Living** . . . *computerized exercise/fitness program*
- ☐ **A Tour of the Faire, Part 1**
- ☐ **Tiny BASIC Shortcuts**
- ☐ **Baudot . . . er . . . Murray, Meet the H8**
- ☐ **8080, Z-80 or 8085**
- ☐ **One Keyboard: Hex and ASCII**
- ☐ **Is the Malibu Model 160 the Printer for Your Business System?**
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- ☐ **Two Systems Sharing the Same Bus**
- ☐ **Computers in Classrooms: Teaching the Teachers**

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- ☐ **DOCUFORM: A Word-Processing System for Everyone!**
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- ☐ **The Amazing 1802**
- ☐ **Who Needs a UART?**
- ☐ **Can't Find It?** . . . *an index for your SWTP BASIC manual*

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- ☐ **(Con)text Editor**
- ☐ **At Last: A Client Timekeeping System**
- ☐ **Troubleshooters' Guide**
- ☐ **Metric-American Conversion Program**
- ☐ **The Heath/DEC Connection** . . . *Part 1: overview*
- ☐ **Home System Demo Program**
- ☐ **Do-It-All Expansion Board for KIM**
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- ☐ **TRS-80 Update: Level II BASIC**
- ☐ **Super Cheap 2708 Programmer**
- ☐ **Something Extra in Mass Storage** . . . *Meca's Alpha-1*
- ☐ **From Big BASIC to Tiny BASIC**

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- ☐ **Budget System** . . . *KIM, keyboard, TV, TVT-6L and AKIM*
- ☐ **The Heath/DEC Connection** . . . *Part 2: H11 system peripherals*
- ☐ **Depreciation Calculations**
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- ☐ **Randomness is Wonderful**
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- ☐ **A Useful Address List Program**
- ☐ **Ready for the Nuthouse?**

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- ☐ **Dura/Itel Selectric for Low-Cost Hard Copy**
- ☐ **A "Gift" That Keeps on Giving**
- ☐ **The Art of Generating Expense Reports**
- ☐ **Deep, Dark Secrets of the TRS-80 (Level I)**
- ☐ **Interfacing the Elf II**
- ☐ **The Care and Feeding of Cassette Tapes, Part 1**
- ☐ **Kilobaud Klassroom** . . . *No. 15: computer I/O III*
- ☐ **Raster Scan Graphics for the 6800** . . . *Part 2: the software*
- ☐ **SWTP 4K RAM Write Protect Option**
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- ☐ **Two Interface Boards from Teletek**
- ☐ **Attention, Chess Buffs!**
- ☐ **The Ups and Downs of Business**
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- ☐ **There Is a Better MIKBUG!**
- ☐ **How to Write Good Application Programs**
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- ☐ An Editor for 6800 BASIC Programs
- ☐ u-Panel for KIM
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- ☐ Say It with a Banner
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- ☐ Keeping Ma Bell Happy

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- ☐ Block-Structured Language for Microcomputers
- ☐ Kilobaud Klassroom, No. 16: I/O IV
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- ☐ Music, Maestro!
- ☐ Madam Dupre's House of the Zodiac
- ☐ Disk Power!
- ☐ Inventory Control with the TRS-80
- ☐ Onward with the COSMAC Elf!
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- ☐ The Apple Speaks—Softly
- ☐ Super Mastermind
- ☐ TRS-80 Level II Reference Manual Index
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- ☐ Use Flowcharts to Communicate
- ☐ Joystick Interface for Your Altair
- ☐ Attack on the Pack!

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- ☐ Teletype's KSR-43
- ☐ The One Percent Forecasting Method
- ☐ Too Many Variables?
- ☐ Kilobaud Klassroom No. 17: I/O V
- ☐ The Electric Pencil
- ☐ How to Talk to Your 8080
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- ☐ The OSI Model 500
- ☐ Sleep Better with a Microcomputer
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- ☐ SWTP CT-1024 Mod
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- ☐ Personal Computing, Meet Photography
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- ☐ The 6502 and Its Little Brothers
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- ☐ Cover Up: PET Home-Decorating Program
- ☐ Teleprinter Output for TRS-80
- ☐ Murphy's Laws and Other Observations
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- ☐ A Look at Terminals
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- ☐ Text Editing for the TRS-80
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Message Display in Assembly Language

This technique brightens 8080 programs; it should work with most memory-mapped displays.

Rod Hallen
Road Runner Ranch
PO Box 73
Tombstone AZ 85638

Table 1 ASCII hex code table showing both normal and reverse video codes. If used in BASIC POKE statements, the decimal equivalents are required. 01 to 1F hex are control codes that are not normally displayed. The Sol and the VDM have a switch which lets you decide whether they will be displayed or not.

ASCII CHAR	NORMAL CODE	REVERSE CODE
NUL	ØØ	8Ø
SOH	Ø1	81
STX	Ø2	82
ETX	Ø3	83
EOT	Ø4	84
ENQ	Ø5	85
ACK	Ø6	86
BEL	Ø7	87
BS	Ø8	88
HT	Ø9	89
LF	ØA	8A
VT	ØB	8B
FF	ØC	8C
CR	ØD	8D
SO	ØE	8E
SI	ØF	8F
DLE	1Ø	9Ø
DC1	11	91
DC2	12	92
DC3	13	93
DC4	14	94
NAK	15	95
SYN	16	96
ETB	17	97
CAN	18	98
EM	19	99
SUB	1A	9A
ESC	1B	9B
FS	1C	9C
GS	1D	9D
RS	1E	9E
US	1F	9F
SP	2Ø	AØ
!	21	A1
"	22	A2
#	23	A3
$	24	A4
%	25	A5
&	26	A6
'	27	A7
(	28	A8
)	29	A9
*	2A	AA
+	2B	AB
,	2C	AC
-	2D	AD
.	2E	AE
/	2F	AF
Ø	3Ø	BØ
1	31	B1
2	32	B2
3	33	B3
4	34	B4
5	35	B5
6	36	B6
7	37	B7
8	38	B8
9	39	B9
:	3A	BA
;	3B	BB
<	3C	BC
=	3D	BD
>	3E	BE
?	3F	BF
@	4Ø	CØ
A	41	C1
B	42	C2
C	43	C3
D	44	C4
E	45	C5
F	46	C6
G	47	C7
H	48	C8
I	49	C9
J	4A	CA
K	4B	CB
L	4C	CC
M	4D	CD
N	4E	CE
O	4F	CF
P	5Ø	DØ
Q	51	D1
R	52	D2
S	53	D3
T	54	D4
U	55	D5
V	56	D6
W	57	D7
X	58	D8
Y	59	D9
Z	5A	DA
[	5B	DB
\	5C	DC
]	5D	DD
↑	5E	DE
←	5F	DF
`	6Ø	EØ
a	61	E1
b	62	E2
c	63	E3
d	64	E4
e	65	E5
f	66	E6
g	67	E7
h	68	E8
i	69	E9
j	6A	EA
k	6B	EB
l	6C	EC
m	6D	ED
n	6E	EE
o	6F	EF
p	7Ø	FØ
q	71	F1
r	72	F2
s	73	F3
t	74	F4
u	75	F5
v	76	F6
w	77	F7
x	78	F8
y	79	F9
z	7A	FA
{	7B	FB
|	7C	FC
}	7D	FD
~	7E	FE
DEL	7F	FF

When you are writing a program and find it desirable to put messages on the video screen to keep the user appraised of what is going on, the PRINT statement in BASIC can take care of this for you very nicely. However, I have noticed that hobbyists seldom use messages or displays when writing programs in assembly language . . . granted, it isn't quite as easy as it is with BASIC, but it isn't all that difficult either. Once the basic print subroutines have been assembled, you can use them in any assembly-language program that requires messages.

The information in this article relates to my particular equipment, but you should be able to make it fit many other hardware configurations as well. I wrote these subroutines for the Sol, but they will also work with any 8080 microprocessor and Processor Technology's VDM-1 video interface board. Many other memory-mapped video boards are similar to the VDM, although the screen memory addresses may be different.

Memory-Mapped Video

The VDM-1 and similar boards, such as PolyMorphic's VTI, are designed for displays of 16 lines with 64 characters per line. This is a total of 1024 character positions (16 × 64), and each character is stored in

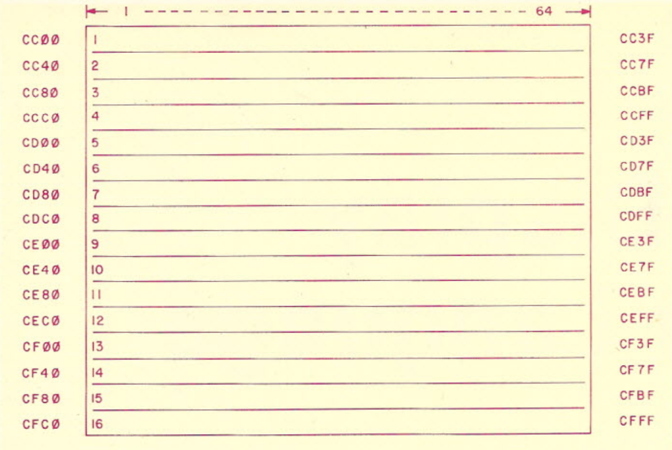


Fig. 1. A memory map of the VDM-1 video screen with the cursor homed (Control K). Otherwise, line addresses can be located anywhere on the screen due to scrolling.

```
ADDRESS   CODE          LABEL     ASSEM LANGUAGE   COMMENTS
ØØØØ      21 D7 CD      START     LXI H SCREEN     LINE START
ØØØ3      11 15 ØØ                LXI D MESSAGE    MESSAGE STORE
ØØØ6      1A            PRINT     LDAX D           GET CHAR
ØØØ7      FE ØØ                   CPI ØØ           IS IT ØØ?
ØØØ9      CA 12 ØØ                JZ END           IF SO END
ØØØC      77                      MOV M,A          MOVE TO SCRN
ØØØD      23                      INX H            NEXT CHAR POS
ØØØE      13                      INX D            NEXT STORE POS
ØØØF      C3 Ø6 ØØ                JMP PRINT        GO BACK AGAIN
ØØ12      C3 Ø4 CØ      END       JMP MONITOR      EXIT
ØØ15      5Ø 45 52 53   MESSAGE   P E R S          DATA STORAGE
ØØ19      4F 4E 41 4C             O N A L
ØØ1D      2Ø 43 4F 4D               C O M
ØØ21      5Ø 55 54 49             P U T I
ØØ25      4E 47 ØØ                N G
```

Program A. This 8080 assembly-language program will print "PERSONAL COMPUTING" in the middle of the screen. Unless you clear the screen first (see text), this will appear right in the middle of whatever happens to be on the screen. The jump at 0012H returns control to my SOLOS monitor.

one byte of memory. A total of 1024 bytes (1K) is thus required. The VDM stores this information in the memory locations between CC00H and CFFFH. All addresses and data in this article are given in the hexadecimal format as indicated by the H suffix. See Fig. 1 for a memory map of my video screen.

A portion of the circuit on the board constantly scans this block of memory and displays its contents on the video monitor. If you change the contents of one byte of this block, that location on the screen will change also. Characters are stored in memory as ASCII hex codes. See Table 1 for a listing of all 128 ASCII characters and codes.

For instance, suppose that memory location CC00H contains 61H. This is a lowercase a in ASCII, and the upper left-hand corner of the screen will display an a. If we change the contents of CC00H to 62H, the a on the screen will change to b. It is possible in this way to put any ASCII character at any location on the screen.

If you want to print "PERSONAL COMPUTING" across the middle of the screen, consult Program A. Note that we enter the screen start address (CDD7H) into the H-L register pair, and the address of the first letter we want to print (0015H) into the D-E register pair. LDAX D brings the character pointed to by D-E to the accumulator. If it is a NUL (00) we are done; otherwise, MOV M,A moves the character to the screen location pointed to by H-L. We increment the screen address and the character storage location and keep going back for another letter until we find 00.

That is simple enough, but if we had more than one line to display or wanted messages at various times during the running of a program, it would be more efficient to make this up as a subroutine, and then we could call it as required.

Program B is really just an expanded version of Program A. The first two lines clear the screen and home the cursor. This is necessary with a scrolling video interface because CC00H equals the upper left-hand corner only when the cursor has been homed. Otherwise, as the display scrolls, CC00H moves upward off the top of the screen, enters at the bottom and moves upward again.

Any time that my monitor program (Processor Technology's SOLOS) is asked to print Control K (0BH), it clears the screen and homes the cursor. Yours may use a different code, but each monitor should have a similar function. Once this is done, you know that each of the screen addresses is as shown in Fig. 1. And it will stay that way as long as you don't cause a scroll by entering a CR or an LF while the cursor is on the bottom line.

OUTLN (0005H) prints three lines. The screen address where the first character is to

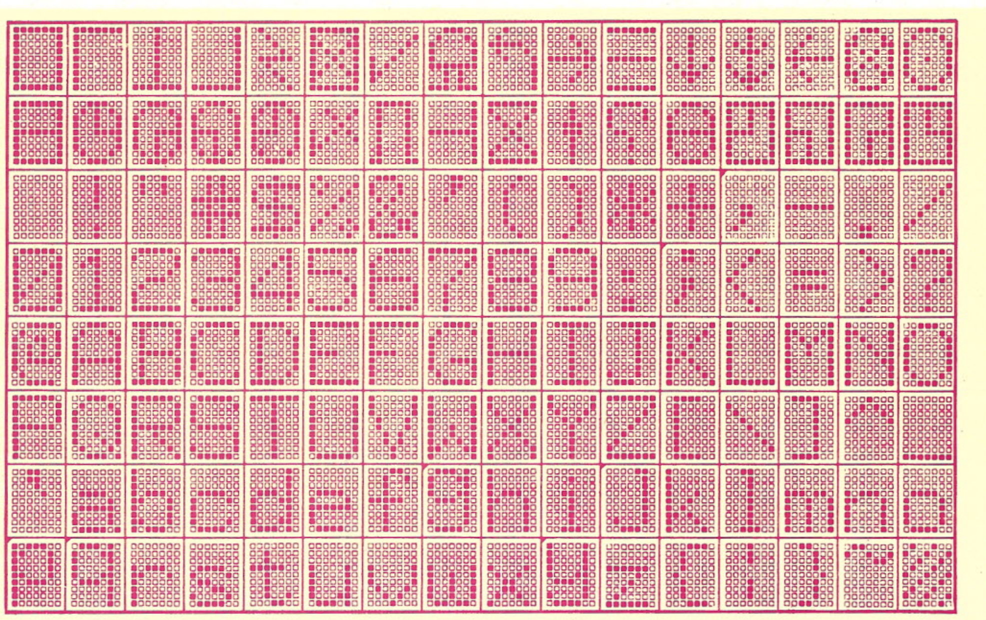


Fig. 2. The contents of the Motorola MCM6574 character generator ROM. Most memory-mapped video interfaces use this or a similar chip. (Drawing courtesy of Motorola Semiconductor)

ADDRESS	CODE	LABEL	ASSEM LANGUAGE	COMMENTS
0000	06 0B	CLEAR	MVI B CTL K	LOAD CTL K
0002	CD 19 C0		CALL SOUT	& DO IT
0005	21 13 CD	OUTLN	LXI H SCRN1	LINE1 START
0008	11 30 00		LXI D MESS1	MESS1 STORE
000B	CD 21 00		CALL PRINT	DO IT
000E	21 99 CD		LXI H SCRN2	LINE2 START
0011	11 50 00		LXI D MESS2	MESS2 STORE
0014	CD 21 00		CALL PRINT	DO IT
0017	21 16 CE		LXI H SCRN3	LINE3 START
001A	11 60 00		LXI D MESS3	MESS3 STORE
001D	CD 21 00		CALL PRINT	DO IT
0020	C9		RETURN	ALL DONE
0021	1A	PRINT	LDAX D	GET CHAR
0022	FE 00		CPI 00	IS IT 00?
0024	C8		RZ	IF SO DONE
0025	77		MOV M,A	MOVE TO SCRN
0026	23		INX H	NEXT CHAR POS
0027	13		INX D	NEXT STORE POS
0028	C3 21 00		JMP PRINT	DO IT
002B	00		NOP	FILLER
002C	00 00 00 00		NOPS	"
0030	41 53 53 45	MESS1	A S S E	DATA STORAGE
0034	4D 42 4C 59		M B L Y	
0038	20 4C 41 4E		L A N	
003C	47 55 41 47		G U A G	
0040	45 20 47 52		E G R	
0044	41 50 48 49		A P H I	
0048	43 53 00 00		C S	
004C	00 00 00 00			
0050	42 59 20 52	MESS2	B Y R	
0054	4F 44 20 48		O D H	
0058	41 4C 4C 45		A L L E	
005C	4E 00 00 00		N	
0060	54 4F 4D 42	MESS3	T O M B	
0064	53 54 4F 4E		S T O N	
0068	45 2C 20 41		E , A	
006C	5A 20 20 38		Z 8	
0070	35 36 33 38		5 6 3 8	

Program B. This routine will print a three-line message. Any time a message is required, the D-E and H-L register pairs are loaded as described in the text and PRINT (0021H) is called. Any of these programs can easily be rewritten to run at locations other than 0000. SOUT, which is called in 0002, is a subroutine in my SOLOS that will print whatever it finds in the B register. If I load Control K (0BH) into register B and call SOUT, the screen will be cleared and the cursor homed. SCRN1, SCRN2 and SCRN3 are the locations on the screen where each of the three lines is to start.

be placed (CCD9H) is loaded into H-L, the address where the message is stored (0030H) is loaded into D-E and PRINT is called.

On RETURN from PRINT the screen and character addresses (CD99H & 0050H) for the second line are loaded and PRINT is called again. When this happens a third time, a three-line message appears on the screen:

ASSEMBLY LANGUAGE GRAPHICS
BY ROD HALLEN
TOMBSTONE, AZ 85638

Anytime later in the program, when you have a message to display, you load D-E and H-L as previously described and call PRINT (0021H). Of course, all messages have to be stored somewhere in memory beforehand, just as those in Program B are stored at (0030H), (0050H) and (0060H).

This approach is especially interesting because you are not limited to letters, numbers and punctuation. Every character in your character generator ROM can be displayed (see Fig. 2). In addition, by adding 80H to the ASCII code (Table 1), you cause the character to be displayed in reverse video.

A space, which is 20H, is a complete lack of any display; its reverse, A0H (20H + 80H), is a complete fill of the character block, which we call a cursor. The use of multiple cursors or other inverse characters makes it possible to draw simple pictures on the screen. A line of cursors completely around the perimeter of the screen would form a box to outline your messages, games, etc. To give you an idea of what is available, Program C was designed to display every character stored in your character generator ROM in both normal and reverse video.

ADDRESS	CODE	LABEL	ASSEM LANGUAGE	COMMENTS
0000	21 00 CC	START	LXI H SCREEN	LOAD SCRN ADD
0003	77	MORE	MOV M,A	MOVE TO SCRN
0004	3C		INR A	INCREMENT CHAR
0005	23		INX H	INCREMENT ADD
0006	47		MOV B,A	SAVE CHAR
0007	3E D0		MVI A SCREND	LOAD END
0009	BC		CMP H	IS IT END?
000A	CA 04 C0		JZ MONITOR	IF SO GO
000D	78		MOV A,B	RESTORE CHAR
000E	C3 03 00		JUMP MORE	GET ANOTHER

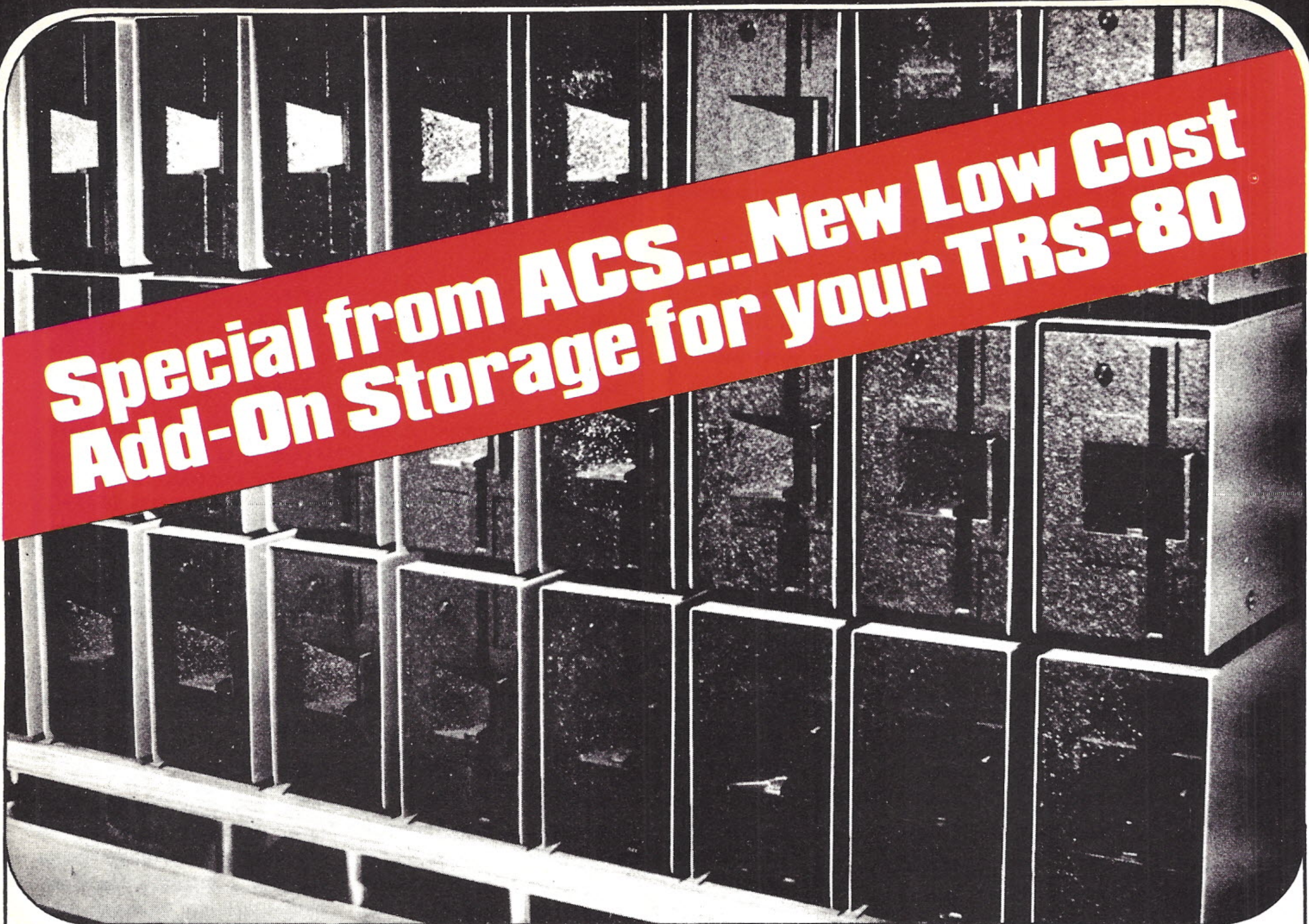
Program C. A simple routine to fill the screen with the contents of the character generator ROM (Fig. 2) in both normal and reverse video. The comparison in 0007H and 0009H is looking for the end of the screen. The last screen address is CFFFH, and when the D register contains D0H, we know that we have reached the address location (D000), which is one byte beyond the end of the screen, and it's time to stop.

Applications

Once you get started, it is amazing what you can do. I've modified a lunar-lander game so that it displays the time, height, velocity, fuel and burn rate in boxes instead of just listing them. Only the current reading is visible, and it is more like a digital control panel. I coupled this with burn rate input from a joystick throttle, and I now have a much more realistic simulator.

The techniques that we have been discussing can also be used with BASIC POKE statements to enable you to display reverse video and normally unprintable control characters. The only difference is that screen addresses and character codes are in decimal instead of hex when using BASIC. Incidentally, the PET has a memory-mapped video system with screen addresses starting at 32768 decimal.

Why not make your assembly-language programs more lifelike? Use your video board as it was intended to be used. Assembly language and a memory-mapped video interface allow for much more versatile displays, which will help to make your programs look much more professional.■



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Implementing an Algorithm

This installment of this periodic series explains algorithms and how to use one.

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By the time you have gained some familiarity with your TRS-80, the desire to strike out on your own (from a program viewpoint) will have set in. This may well take the form of programming around an algorithm. An algorithm is a simple set of clearly defined steps, which, if followed, allows you to solve a real problem that is much more complex than any one of the simple steps that make up the solution.

As an example, take a peek at one algorithm for converting a hexadecimal number to its decimal equivalent. Let us take a typical hex value, 3CC0. The conversion algorithm says: take the least significant digit (0) and multiply it by 16 raised to the zero power. Take the next digit to the left and multiply it by 16 raised to the one power. Take the next digit to the left and multiply it by 16 raised to the second power (16^2). Take the last digit and multiply it by 16 raised to the third power (16^3).

When you have these four products, you then add them together, and their sum will be the value of the hex number converted to its decimal, or base 10, value.

The algorithm assumes that you understand that the hexadecimal system uses 16 symbols to represent its values. They are the numbers 0 through 9, which carry their normal decimal values. The letters A through F carry the values 10 through 15. This is one more example of the notion that 0 is a real number. If you still have not become used to the idea, you are not alone, so take heart.

```
  5  CLS
 10  INPUT "HEX NUMBER TO CONVERT TO DECIMAL";J$
 20  FOR X= 1 TO LEN(J$)
 30  Y=Y+1
 40  J(X) = ASC(MID$(J$,Y,1))
 50  IF J(X) => 65 THEN J(X) = J(X)-55: GOTO 60
 55  IF J(X)< = 57 THEN J(X) = J(X) -48
 60  NEXT X
 70  FOR X = 1 TO LEN (J$)
 80  N=N+1
 85  B = LEN(J$) -N
 90  J(X) =J(X) * 16 ↑ B
 95  PRINT J(X)
100  NEXT X
110  FOR X = 1 TO LEN (J$)
120  SUM = SUM + J(X)
130  NEXT X
140  PRINT SUM
150  CLEAR: GOTO 10
```

Program listing. Hex to decimal conversion.

Now that we have the algorithm, take a look at the program listing to see how we can implement this to make a workable conversion program.

The Program

Now let's tear some of this programming apart. Lines 10 through 60 put the discrete values of each hex digit into the cells of an array named J. The number of cells in the array is determined by line 20 using the LEN(J$) command. In the case of our test number 3CC0, LEN(J$) would produce a value of 4, hence we would have an array with four cells. This would make the loop represented by lines 20 through 60 execute four times.

The counter, Y, which is within this loop, would increment by 1 with each pass through the loop. This would cause the expression in line 40 to examine each array cell, in turn, in terms of its contents.

Lines 50 and 55 examine the ASCII value packed into each cell and, if the conditional expressions are satisfied, make the indicated subtractions. You will find a table of ASCII values on page C/2 of your Level II manual. Examining these, you can determine that line 50 concerns itself with the values of symbols A through F, converting them to numerical values of 10 through 15. Line 55 does the same job on the symbols 0 through 9. If it seems strange to say that 1, 2, 3, 4, etc., are symbols, that is exactly what they are . . . they represent quantities of something. Remember, Roman numerals are symbols also; they meant the same thing to Fabius as ours do to us—VI apples and 6 apples are the same thing.

Now that we have the numerical value of each hex digit packed into the cells of array J, we can contine with the next step of the algorithm.

Lines 70 to 100 serve to determine the proper value of the power of 16 that each cell is to be multiplied by. Line 95 is convenient since it prints out the multiplied value of each cell's contents. In the final program this line may be deleted, but is convenient to show just how the program is operating.

If we ran the program to this point we would see a printout on the screen as follows:

```
12288
 3072
  192
    0
```

This would represent the contents of each cell multiplied by the appropriate power of 16, assuming that we had input our test number 3CC0 to be converted to its decimal value. If we added up these values with a graphite character generator (pencil), we would come up with the decimal value of 15552, which is 3CC0 hex.

Lines 100 through 140 do this for us, summing the contents of the array cells. Line 150 restores the program to its original state with the CLEAR command and returns the program to the beginning, allowing us to input another number for conversion if we so desire.

Fundamentally, we have examined in some small detail the steps needed to implement an

```
New line 10 INPUT "Number to convert to Decimal"; J$
New line 15 INPUT "BASE CODE NUMBER";W
New line 18 IF W > 16 print "BASE LIMIT EXCEEDED": GOTO 150
New line 41 IF J(X) > 70 PRINT "PROGRAM LIMIT EXCEEDED":GOTO 150
New line 43 IF J(X) < 48 PRINT "NONNUMERIC INPUT":GOTO 150
New line 90 J(X) = J(X) * W↑B
```

Example 1.

algorithm. The largest program is simply composed of a series of small steps, and if they all mesh properly then the program works. If not, then we have to apply a squirt of electronic FLIT and DEBUG.

Modification

You may be thinking that this same program could be altered to convert other bases—for example, binary, quinary or octal—to their decimal equivalents. Let's nourish this notion and follow it through. Make the changes and additions to the program listing shown in Example 1.

What have we done? First, we have set a limit on just how high a base we can convert to, base 16 or hex, which is accomplished in line 18. This is a practical limit, since our realistic limit of interest is generally binary, octal and hex, although some folks may revel in quinary, or base 5.

Line 15 permits us to enter the base of interest. Thus, if we entered FFFF as a hex number, we would supply 16 when the program asked us to input or supply the base code number. Lines 41 and 43 supply hedges against inputting improper symbols. You can readily determine just what they are hedging against by referring to your chart of ASCII symbols in the Level II manual. Line 90 serves to supply the proper exponent to produce the correct values in each array cell.

Suppose we run the revised program and input the number FFFF. Assuming that line 95 is still with us, we would see that FFFF hex is 65535 decimal (see Example 2). If we input 17 and a base code number of 8, we are asking what is the decimal value of 17 base 8. The answer is 15 (see Example 3). If we input a typical binary number such as 0110, the program will equate a decimal value of 6 (see Example 4).

This program, and its modification, is a demonstration of methodology, *not* perfection. You can fool it if you try, since there are several doors that have been left unlocked. However, if you remember certain basics and apply a bit of common sense it will be useful. Just remember that any base uses a number one less than the base as its highest value symbol. Thus, the highest value symbol in octal is 7; the highest value symbol in hex is 15; and the highest value symbol in quinary is 4. This admonition is a clue as to just what doors have been left unlocked. When you find them, modify the program to lock them up and take a further step toward becoming a programming whiz! ■

```
NUMBER TO CONVERT? FFFF
BASE CODE NUMBER ? 16
                         61440
                          3840
                           240
                            15
                         65535
```

Example 2.

```
NUMBER TO CONVERT? 17
BASE CODE NUMBER ?   8

                     8
                     7

                    15
```

Example 3.

```
NUMBER TO CONVERT ? 0110
BASE CODE NUMBER ?  2

                    0
                    4
                    2
                    0

                    6
```

Example 4.

6800 Tape System

This low-cost, high-speed tape system for the SWTP 6800 costs about $5 to construct.

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Dayton OH 45432

When I received a back-order notice for my SWTP AC-30 tape interface, I decided to try to produce something that would serve in the interim. The result is a tape system that loads my 8K BASIC in one minute and costs around $5, mostly for a regulated 5 volt power supply. Take 5 volts from the computer and the rest probably can come from the junk box.

This system can be used as a stand-alone operation or as a useful supplement to paper tape. I now use it as a supplement to the 300 baud AC-30 for long programs.

The complete circuit, shown connected to the MP-C control board, is given in Fig. 1. The single 7400 quad NAND gate chip can be mounted on any type board, or the leads can even be soldered directly to the pins. I mounted the chip on a small DIP socket board from Radio Shack (2/$.99). External components are soldered directly on the board pads. The two diodes in the circuit are small, glass diodes of unknown vintage.

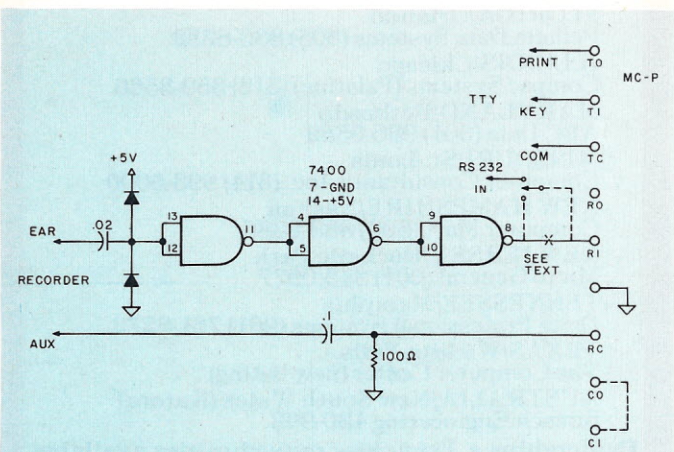


Fig. 1. The complete circuit connected to the MP-C serial control board. The dashed switch is discussed in the text.

How It Works

SWTP thoughtfully provides a reader control (RC) output on their MP-C serial control board. This circuit is intended for automatic control of reader/punch for the paper-tape system, but makes a fine place to obtain output data for the tape recorder. When on, approximately 12 volts are supplied to the recorder AUX input through a 0.1 disk capacitor.

The result, when reader control is turned on and off at high speed, is a distorted sine wave on the tape. When played back through the 7400, an asymmetrical square wave is obtained. It is possible that a Schmitt trigger would have been a better choice, but I had a 7400 on hand.

Terminal RI on MP-C requires a jumper to ground when the 20 mA loop is used. The 7400 provides this by holding this point low with no tape input. This condition must also exist for the Play program software to operate properly.

It is possible that some tape recorders will have an inverted output, although none of the ones I tried did. The unused gate in the 7400 can be used to rectify this if it exists on your recorder.

Under software control, RC is turned on and off at a high rate for a zero and at a lower rate for a one. Square waves with different widths for ones and zeros result when the tape is played back through the 7400. This difference in widths is detected in the Play program.

Software

Program A is used for recording tapes and Program B loads the recorded data into the computer. Both programs require that the starting and ending addresses be entered into memory locations A002-5 before running. I did this because I wanted the ability to relocate programs anywhere in memory. Incidentally, both programs are completely relocatable (using MIKBUG scratch memory) and can be loaded wherever is handy for you.

If you preferred to have addresses on tape, it would be simple to modify the program to record them at the beginning of the tape. Program B could have a routine added near the top to read these addresses and store them in A002-5. Extensive use of subroutines in both programs should make modification possible without major disruptions to the original programs.

In Program A, the two subroutines ZERO and ONE turn RC on and off. Timing is done in the two subroutines TIMEZ and TIMEO, with the timing being set by the second byte in lines 950 and 1010, respectively. Each frame is 256 bytes long and is followed by a checksum. An eight-second leader of all zeros is produced at the beginning of the tape. This provides synchronization for the Play program and permits some leeway in positioning the beginning of the tape for playback.

A note is necessary for those who find and question such things. There are several statements in Program A that do not appear to do anything. These are marked Equalizing Delay. It is not necessary that the on and off time of a bit be equal, but the off time of each type of bit, one or zero, should be the same.

Since overhead in different sections of the program took varying times to run, it was necessary to pad the shorter loops with fillers. These fillers were selected to provide approximately the desired number of machine cycles and could be anything that didn't upset the program. My original program did not have these and worked, but the playback tolerance was less.

In the Play program, lines 750

and 860 separate the ones and zeros. If at the end of the delay the input was low, the bit would be a zero; if it was still high, the bit would be a one. With no signal, input is high. Line 200 detects this and loops until the tape starts.

When input is detected, a two-second delay is entered to allow tape to reach speed. The program then searches for the first start bit, a one. Each byte is terminated by a zero stop bit that allows the program time to reset.

Recorders and Tape

As you might expect, system operation is somewhat sensitive to the recorder used. A machine with a high recording level and high audio output works best. Though I have not tried one, I suspect that the $19.95 variety would not be satisfactory. I have three recorders (Sears 21676 and 21683 and Lafayette RK-100) that all work well.

My initial programs did not have checksums. When I added these, sometimes I could load a tape and sometimes I could not. After much frustration, I ran an oscilloscope test and found that the new tape I was using (Radio Shack 44-602A) had a lower output level than my previous tape. In addition, there were severe fluctuations in amplitude at times.

I purchased several brands of tape and ran some tests. Scotch Master I (Normal Bias) and Maxell UDXL I worked very well. BASF Professional I, BASF Performance Series and TDK AD-60 also were satisfactory, although the TDK showed a small tendency to vary in amplitude, and the BASF Professional contained about a 0.75 second dropout in one spot. Any good high-output tape should work.

Using the System

To make a tape, enter the starting and ending addresses into A002-5. Enter the Record program start address into A048-9. Set the recorder volume control at maximum (this is important) and the tone control at treble. Start the recorder, then enter a "G" from the keyboard. When completed, control will be returned to the monitor.

To load a program into memory, enter the starting and ending addresses into A002-5. Enter the address of the Play program into A048-9. Set the recorder volume control at maximum and the tone control at treble. Set the tape near the beginning of the eight-second leader. Enter "G" from the keyboard then turn on the recorder. Upon a successful load, control will be returned to the monitor. If a checksum error is encountered, a question mark will be displayed and control will be returned to the monitor.

Tuning the Play Program

Your programs should load with the Play program as given, but some fine tuning to your recorder may provide greater playback tolerance. I suggest that a short loop program be written to load about four pages of memory with alternating 00 and FF. Make a recording of this section of memory, then play it back into a different section of memory.

A return to monitor without a question mark indicates a successful load. If you get a checksum error, or even if you don't, increment and decrement the values in lines 750 and 860 one step at a time and try again. The aim is to find the maximum and minimum values that load properly. The spread of values should be four or five numbers. Set the program numbers to the center value for maximum tolerance in playback.

Alternate Connections

If your system uses a terminal connected to the 20 mA loop of MP-C, the connections given in Fig. 1 will permit operation with complete separation between the terminal and the tape system without any switching. If, on the other hand, your terminal is connected to the RS-232 input, RI of MP-C, you cannot have another device

Program A.

```
00010                      NAM    RECORD
00020               *   PROGRAM A - RECORD PROGRAM
00030               *
00040      E0E3     CONTRL EQU    $E0E3
00050      A002     STADD  EQU    $A002
00060      A00F     ENDAD  EQU    $A00F
00070      A00B     CKSUM  EQU    $A00B
00080      A00A     FRAME  EQU    $A00A
00090      A00C     TEMP1  EQU    $A00C
00100      A00D     TEMP2  EQU    $A00D
00110                      OPT    0
00120 2F00                 ORG    $2F00
00130 2F00 8E A047         LDS    #$A047   SET STACK
00140 2F03 FE A004         LDX    $A004    GET END ADDRESS
00150 2F06 08              INX
00160 2F07 FF A00F         STX    ENDAD    SAVE END ADDRESS
00170 2F0A 86 D6           LDA A  #$D6     LOAD
00180 2F0C B7 A00C         STA A  TEMP1    DELAY
00190 2F0F 7F A00D         CLR    TEMP2    COUNTERS
00200 2F12 FE A002         LDX    STADD    POINTER TO START ADDRESS
00210 2F15 8D 51    LEAD1  BSR    DELAY    EQUALIZING DELAY
00220 2F17 8D 4F    LEAD2  BSR    DELAY
00230 2F19 8D 70           BSR    ZERO     OUTPUT EIGHT SECONDS
00240 2F1B 7C A00D         INC    TEMP2    OF ZERO LEADER
00250 2F1E 26 F5           BNE    LEAD1
00260 2F20 7C A00C         INC    TEMP1
00270 2F23 26 F2           BNE    LEAD2
00280 2F25 4F              CLR A           EQUALIZING DELAY
00290 2F26 7F A00A STFRAM  CLR    FRAME    CLEAR FRAME COUNTER
00300 2F29 7F A00B         CLR    CKSUM    CLEAR CHECKSUM
00310 2F2C 8D 6C    NEXT   BSR    ONE      OUTPUT START BIT
00320 2F2E E6 00           LDA B  0,X      GET DATA BYTE
00330 2F30 17              TBA             SAVE DATA BYTE
00340 2F31 FB A00B         ADD B  CKSUM    UPDATE CHECKSUM
00350 2F34 F7 A00B         STA B  CKSUM    SAVE CHECKSUM
00360 2F37 C6 08           LDA B  #$08     SET BIT COUNTER
00370 2F39 8D 2E           BSR    DATA     GO OUTPUT DATA
00380 2F3B 08              INX             INCREMENT DATA POINTER
00390 2F3C BC A00F         CPX    ENDAD    DATA COMPLETED?
00400 2F3F 26 11           BNE    COUNT    NO - BRA COUNT
00410 2F41 8D 25           BSR    DELAY    EQUALIZING DELAY
00420 2F43 8D 55           BSR    ONE      OUTPUT START BIT
00430 2F45 8D 21           BSR    DELAY    EQUALIZING DELAY
00440 2F47 C6 08           LDA B  #$08     SET BIT COUNTER
00450 2F49 B6 A00B         LDA A  CKSUM    GET CHECKSUM
00460 2F4C 43              COM A           COMPLEMENT CHECKSUM
00470 2F4D 8D 1A           BSR    DATA     GO OUTPUT CHECKSUM
00480 2F4F BD E0E3         JSR    CONTRL   EXIT
00490 2F52 7A A00A COUNT   DEC    FRAME    FRAME COMPLETED?
00500 2F55 26 D5           BNE    NEXT     NO - GET NEXT BYTE
00510 2F57 8D 41           BSR    ONE      OUTPUT STARTBIT
00520 2F59 36              PSH A           EQUALIZING DELAY
00530 2F5A 32              PUL A
00540 2F5B C6 08           LDA B  #$08     SET BIT COUNTER
00550 2F5D B6 A00B         LDA A  CKSUM    GET CHECKSUM
00560 2F60 43              COM A           COMPLEMENT CHECKSUM
00570 2F61 8D 06           BSR    DATA     OUTPUT CHECKSUM
00580 2F63 7F A00D         CLR    TEMP2    EQUALIZING DELAY
00590 2F66 20 BE           BRA    STFRAM   START NEW FRAME
00600 2F68 39       DELAY  RTS
00610 2F69 46       DATA   ROR A           ROTATE BIT INTO CARRY
```

```
2F6A 36                PSH A           SAVE A
2F6B 24 0D             BCC    ZO       CARRY CLEAR?
2F6D 8D 2B             BSR    ONE      NO - BIT WAS A ONE
2F6F 8D F7             BSR    DELAY
2F71 32                PUL A           RESTORE A
2F72 5A                DEC B           ALL BITS RECORDED?
2F73 26 F4             BNE    DATA     NO - THEN REPEAT
2F75 7F A00D           CLR    TEMP2    EQUALIZING DELAY
2F78 20 0B             BRA    STOP     YES - GO GET STOP BIT
2F7A 8D 0F     ZO      BSR    ZERO     BIT WAS A ZERO
2F7C 8D EA             BSR    DELAY
2F7E 32                PUL A           RESTORE A
2F7F 5A                DEC B           ALL BITS RECORDED?
2F80 26 E7             BNE    DATA     NO - THEN REPEAT
2F82 7F A00D           CLR    TEMP2    EQUALIZING DELAY
2F85 8D 04     STOP    BSR    ZERO     OUTPUT STOP BIT
2F87 7F A00D           CLR    TEMP2    EQUALIZING DELAY
2F8A 39                RTS             BYTE COMPLETED
2F8B 86 3C     ZERO    LDA A  #$3C
2F8D B7 8007           STA A  $8007    TURN ON RC
2F90 8D 17             BSR    TIMEZ    BRANCH TO TIME COUNTER
2F92 86 34             LDA A  #$34
2F94 B7 8007           STA A  $8007    TURN OFF RC
2F97 8D 10             BSR    TIMEZ    BRANCH TO TIME COUNTER
2F99 39                RTS
2F9A 86 3C     ONE     LDA A  #$3C
2F9C B7 8007           STA A  $8007    TURN ON RC
2F9F 8D 10             BSR    TIMEO    BRANCH TO TIME COUNTER
2FA1 86 34             LDA A  #$34
2FA3 B7 8007           STA A  $8007    TURN OFF RC
2FA6 8D 09             BSR    TIMEO    BRANCH TO TIME COUNTER
2FA8 39                RTS
2FA9 37        TIMEZ   PSH B           SAVE B
2FAA C6 20             LDA B  #$20     SET ZERO TIMER
2FAC 5A        AZ      DEC B           TIME UP?
2FAD 26 FD             BNE    AZ       NO - GO BACK
2FAF 33                PUL B           YES - RESTORE B
2FB0 39                RTS
2FB1 37        TIMEO   PSH B           SAVE B
2FB2 C6 3D             LDA B  #$3D     SET ONE TIMER
2FB4 5A        AO      DEC B           TIME UP?
2FB5 26 FD             BNE    AO       NO - GO BACK
2FB7 33                PUL B           YES - RESTORE B
2FB8 39                RTS
                       END
```

Program B.

```
                       NAM    PLAY
               *   PROGRAM B - PLAY PROGRAM
               *
     E0E3      CONTRL  EQU    $E0E3
     E1D1      OUTEE   EQU    $E1D1
     A00E      COUNT   EQU    $A00E
     A00D      FRAME   EQU    $A00D
     A00B      CKSUM   EQU    $A00B
     A002      STADD   EQU    $A002
     A00F      ENDAD   EQU    $A00F
                       OPT    O
2E00                   ORG    $2E00
2E00 86 3C             LDA A  #$3C
2E02 B7 8007           STA A  $8007    TURN OFF TTY
2E05 FE A004           LDX    $A004    GET END ADDRESS
2E08 FF A00F           STX    ENDAD    SAVE END ADDRESS
2E0B CE 8004           LDX    #$8004   MP-C INPUT
2E0E 0D        CH      SEC
2E0F 69 00             ROL    0,X      TAPE STARTED?
2E11 25 FB             BCS    CH       NO - THEN GO BACK
2E13 7F A00D           CLR    FRAME    SET UP 2 SECOND DELAY TO
2E16 5F                CLR B           PERMIT TAPE TO GET UP
2E17 86 FD             LDA A  #$FD     TO SPEED
2E19 4C        L1      INC A
2E1A 26 02             BNE    L2
2E1C 20 0C             BRA    GO
2E1E 5C        L2      INC B
2E1F 26 02             BNE    L3
2E21 20 F6             BRA    L1
2E23 7C A00D   L3      INC    FRAME
2E26 26 FB             BNE    L3
2E28 20 F4             BRA    L2
2E2A 7F A00B   GO      CLR    CKSUM
2E2D 8D 40     NEXT    BSR    START    GO LOOK FOR DATA
2E2F FE A002           LDX    STADD    POINTER TO DATA STORAGE
2E32 A7 00             STA A  0,X      STORE DATA BYTE
2E34 BB A00B           ADD A  CKSUM    UPDATE CHECKSUM
2E37 B7 A00B           STA A  CKSUM
2E3A BC A00F           CPX    ENDAD    LAST DATA BYTE?
2E3D 27 1C             BEQ    CK2      YES - THEN GO GET CHECKSUM
2E3F 7A A00D           DEC    FRAME    END OF FRAME?
2E42 27 06             BEQ    CK1      YES - THEN GO GET CHECKSUM
2E44 08                INX             INCREMENT POINTER
2E45 FF A002           STX    STADD    SAVE POINTER
2E48 20 E3             BRA    NEXT     GO BACK FOR NEXT BYTE
2E4A 8D 23     CK1     BSR    START    READ CHECKSUM FROM TAPE
2E4C 4C                INC A           INCREMENT CHECKSUM
```

connected to the same input without additional circuits for isolation.

The dotted switch circuit of Fig. 1 shows one way around this. Simply break the line from your terminal to RI and add an SPDT switch with one switch contact going to your terminal and the other going to the tape system. The record output on RC is isolated and requires no changes.

The procedure to load a tape is the same with one exception. After entering "G," flip the switch to "tape," then start the recorder. End-of-load or checksum errors will still be indicated on your terminal. In fact, a checksum error causes a string of question marks on the CT-64 as it tries to read the odd tape characters.

My terminals now consist of a KSR-33, an AC-30 and a CT-64. Since my programs all use the MP-C interface, I have added an external switch that changes baud rates and switches all connections between terminals. This tape system is permanently connected to the TTY side.

I did try the switch method described above and it worked fine with the CT-64, although some changes in Play software were required. The program listed here works with either terminal.

If you would like complete isolation from the MP-C, the reader control output on any SWTP serial board will serve for making tapes. For input, I believe a parallel port with the tape output connected to one of the D7 inputs will work. You will, of course, have to make any necessary address changes. Parallel boards use noninverting inputs, so it may be necessary to use the fourth section of the 7400 as an inverter.

Speed Changes

The timing values given in Program A are a compromise between speed and reliability. They should provide reliable performance with most good recorders.

If you wish to experiment, a change of one in either direction changes the 8K load time

EXATRON STRINGY FLOPPY
Owners Association Newsletter

Secretary, Fred Waters

Have you been following this newsletter for the last few months? Have you a TRS-80, an SWTP, or an S-100 personal or business computer, but are looking for an alternative to get you away from the audio cassette recorder/player for program storage? If so, you need the Exatron Stringy Floppy. Check previous editions of the Newsletter and the end of this page for more details.

THE ESF STARTER KIT

Here's an offer you should take a close look at. When you start out with a Stringy Floppy for your TRS-80, you usually want the ESF, a BUS-EX (bus extender so you can connect both the ESF and another device to the bus without an expansion interface), some tape wafers of various lengths, and the ESF-80 Monitor. To simplify things on our end, and to give you a price break on your first order, we have put together the ESF Starter Kit. The list price of the items above is $314.45; the Starter Kit with a mix of 4 5-foot tapes, 6 10-footers, 8 20-footers, and 2 50-footers, lists for $299.50. Now, on top of that, when you get your Starter Kit you'll find inside an order form with a credit coupon. Get a friend to order the Starter Kit, and you get a free box of 10 wafers, a $20 value, with your choice of mix. A saving of about $35 on this offer! (If you already own a Stringy Floppy, we have already sent you this order blank and coupon for a friend.)

THE ESF-80 MONITOR

When Vern Tallman, whose picture you see above, first got his Stringy Floppy, he was already familiar with the capabilities and limitations of the TRS-80. He wanted some debug functions for program development, and he wanted to get the maximum use out of the ESF. What's more, he had the skills and talent necessary to write a monitor himself. The outcome is what he calls the ESF-80 Monitor. Vern is an expert programmer, and this Monitor is a beautiful piece of work.

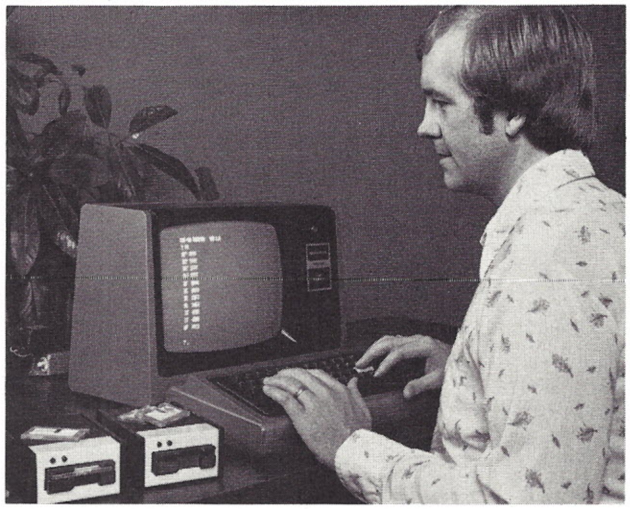
The ESF-80 Monitor has a two-fold purpose: one, to provide a machine language debugging tool, and two, to facilitate the transition from cassette mass storage to storage on the ESF wafer. It's 2K bytes long, and is initially loaded near the start of RAM, at 4300 hex. It then passes interactive control to a built-in relocator so you can move it anywhere you want in RAM to suit your memory usage. It is supplied on an ESF wafer, and is accompanied by a fine users manual. Hexadecimal addresses and hex byte designations are used, and invalid entires are signaled by an error message.

There are three general groups of functions and commands. The first is the relocator, briefly described above. The second group is the debug aids. There are nine: Inspect and Change the contents of a specified address; Memory Dump, giving a paged display in hex; Character Dump, giving a paged display in ASCII; Store Constant, to fill a block of memory with a specified byte; Go To, either for changing control to a specified address or for resuming execution after a breakpoint; Set Breakpoint, to interrupt program execution to examine registers; Clear Breakpoint, to do just that; Print Registers, to display contents of all 11 16-bit registers, including the stack pointer; and Alter Register, to change register contents as desired. All commands are two letters.

The third group of commands is the utility functions. There are three: Load Cassette loads a SYSTEM format tape into memory, and then displays the start, end, and entry point addresses; Write Program uses those parameters to write the program on an ESF wafer for future use; and Copy Cassette will copy a SYSTEM format tape from memory onto a cassette.

Pretty neat, isn't it! And it helps us all. The ESF-80 Monitor is available from ESFOA for $9.95, plus S&H and tax if applicable.

In passing, I have to say that this is another "I told you so" story about how effective the Owners Association and the ESF workshops can be. Does that give you an idea? Read on!



Vern Tallman, a member of the ESF Owners Association for only a few months, has just completed the ESF-80 Monitor for the TRS-80. A programmer by profession, Vern has been a long time enthusiast of microcomputing and is currently working on several ESF projects involving the TRS-80 and the SWTPC 6800. His work on the ESF-80 Monitor is sure to be appreciated by users making the transition from cassette to the Stringy Floppy.

START A WORKSHOP

If you've been following our monthly newsletters, you know that the Exatron Stringy Floppy Owners Association—ESFOA—is a voluntary organization of owners and prospective owners of the ESF. The principal activity of ESFOA to date for the TRS-80 has been the Saturday morning workshop held at the Exatron plant. These informal get-togethers have been very successful in expanding our knowledge and enhancing the usefulness of the ESF. Almost all hardware and software improvements have been the result of the efforts of enthusiastic and talented volunteers. This benefit of ESF ownership is available at the moment only to those in the general area of Santa Clara, California. It is high time that this benefit be distributed—that the organization of ESF workshops be encouraged wherever ESF owners can be found.

YOU ARE NEEDED to help organize a local ESF workshop! First send me a postal card telling me you are interested, and include your address and phone number. Then we'll publish your name and address as a focal point for others of like mind, and we'll send you a printout of ESF owners near you. We will also send you a procedure and some minimal requirements for getting started. This idea really snowballs, because everyone benefits, and you'll soon find yourself in the middle of a remarkable idea exchange center.

HOW TO ORDER

All versions of the Exatron Stringy Floppy have a 30-day moneyback guarantee and a 1-year warranty. The ESF is shipped from the factory assembled and tested, and is normally in stock ready to ship. For the fastest delivery, phone in your credit card or COD order.

Users manuals for all versions of the ESF and complete information packages are available at no charge.

Base price for the TRS-80 ESF, $249.50; for the SWTP ESF, $250.00; for the S-100 ESF, $289.50. A 2-for-1 BUS-EX is $15.00; the ESF-80 Monitor is $9.95.

If you have any questions about the product, about Exatron, or ESFOA, please call the Hot Line. Address letters to ESFOA, 3559 Ryder St., Santa Clara, CA 95051

Stringy Floppy is a trademark of Exatron Corporation

HOT LINE **800-538-8559**

WITHIN CALIFORNIA **408-737-7111**

```
2E4D BB A00B          ADD A  CKSUM
2E50 26 14            BNE    ERROR   BRANCH IF CHECKSUM ERROR
2E52 FE A002          LDX    STADD   GET LAST DATA POINTER
2E55 08               INX            INCREMENT TO NEXT POSITION
2E56 FF A002          STX    STADD   SAVE POINTER
2E59 20 CF            BRA    GO      GO BACK FOR NEXT FRAME
2E5B 8D 12     CK2    BSR    START   READ CHECKSUM FROM TAPE
2E5D 4C               INC A          INCREMENT CHECKSUM
2E5E BB A00B          ADD A  CKSUM
2E61 26 03            BNE    ERROR   BRANCH IF CHECKSUM ERROR
2E63 BD E0E3          JSR    CONTRL  ALL DONE - EXIT
2E66 86 3F     ERROR  LDA A  #$3F
2E68 BD E1D1          JSR    OUTEE   OUTPUT QUESTION MARK
2E6B BD E0E3          JSR    CONTRL  ERROR - EXIT
2E6E 39        STORE  RTS            RETURN TO STORE BYTE
2E6F CE 8004   START  LDX    #$8004  MP-C INPUT
2E72 86 08            LDA A  #$08    LOAD BIT COUNTER
2E74 B7 A00E          STA A  COUNT   SAVE BIT COUNTER
2E77 0D        LOW    SEC
2E78 69 00            ROL    0,X     CLEAR ANY LOWS
2E7A 24 FB            BCC    LOW
2E7C 5F               CLR B          CLEAR TIMER
2E7D 0D        HI     SEC
2E7E 69 00            ROL    0,X     READ INPUT
2E80 24 03            BCC    STBIT   STILL HIGH?
2E82 5C               INC B          YES - INCREMENT TIMER
2E83 20 F8            BRA    HI      GO BACK AND TEST AGAIN
2E85 C1 13     STBIT  CMP B  #$13    IS DATA A START BIT?
2E87 23 EE            BLS    LOW     NO - GO BACK AND LOOK AGAIN
2E89 0D        DATAL  SEC
2E8A 69 00            ROL    0,X     CLEAR ANY REMAINING LOWS
2E8C 24 FB            BCC    DATAL
2E8E 5F               CLR B          CLEAR TIMER
2E8F 0D        DATAH  SEC
2E90 69 00            ROL    0,X     READ INPUT
2E92 24 03            BCC    DATAA   STILL HIGH?
2E94 5C               INC B          YES - THEN INCREMENT TIMER
2E95 20 F8            BRA    DATAH   GO BACK AND TEST AGAIN
2E97 C1 13     DATAA  CMP B  #$13    IS BIT A ZERO?
2E99 23 03            BLS    ZERO
2E9B 0D        ONE    SEC            BIT WAS A ONE - SET CARRY
2E9C 20 01            BRA    LODA
2E9E 0C        ZERO   CLC            BIT WAS A ZERO - CLEAR CARRY
2E9F 46        LODA   ROR A          ROTATE INTO A-REGISTER
2EA0 7A A00E          DEC    COUNT   BYTE ALL DONE?
2EA3 27 C9            BEQ    STORE   YES - THEN GO STORE IT
2EA5 20 E2            BRA    DATAL   NO - GO BACK FOR NEXT BIT
                      END
```

about two seconds. A good recorder can be made to load 8K BASIC in under 50 seconds, including the eight-second leader. However, I feel more comfortable with a wide playback tolerance. If you change the recording times, the playback timing in Program B must also be adjusted in the same direction.

Stand-Alone Use

If a system such as this is the only mass-storage device you have, you will face a problem because the Play program must be in memory before other programs can be loaded. Therefore, you will need to load Program B by hand first, unless you have it in ROM. I put the program out of the way and leave the computer on all the time. However, you can enter the Play program by hand from the keyboard, load an 8K tape from it and have this program running while the same 8K program is still loading at the 300 baud rate. ■

We're about to make a new name for ourselves.

Not that the old one was so bad. As Ithaca Audio, we've made quite a name for ourselves. As the source for CPU, memory, video display and disk controller boards to upgrade other makers' mainframes and peripherals. The company that makes those neat little RAM expansion kits. And the folks behind the world's only Z-80 Pascal compiler.

But as much as we've enjoyed improving other people's equipment, we've been quietly moving towards larger endeavors, with a lot of encouragement from our customers. Listening to people's problems, as well as their needs. And, as a prime mover behind the IEEE S-100 Bus Standard, answering some really knotty questions.

One of the results is our new identity. And our first new product: the Intersystems DPS-1. An IEEE S-100 compatible mainframe with features that live up to its looks. *Dependable* operation to 4 MHz. Twenty-card capacity. A modular power supply. And something no one else has—built-in breakpoints to give you a faster, more powerful tool for testing software as well as hardware. *Directly* accessible from an easy-to-use front panel that's as *reliable* as it is functional. In short, an intelligently-designed computer for the intelligent user.

There's a lot more to Intersystems. In hardware. And software. All available through the nationwide dealer network we're now assembling.

You can watch this magazine for updates. Or contact us directly for straight, friendly answers and detailed information from key staff people. Just the way you always have. Because even though we're making a new name for ourselves, we'll never forget who made it possible.

InterSystems

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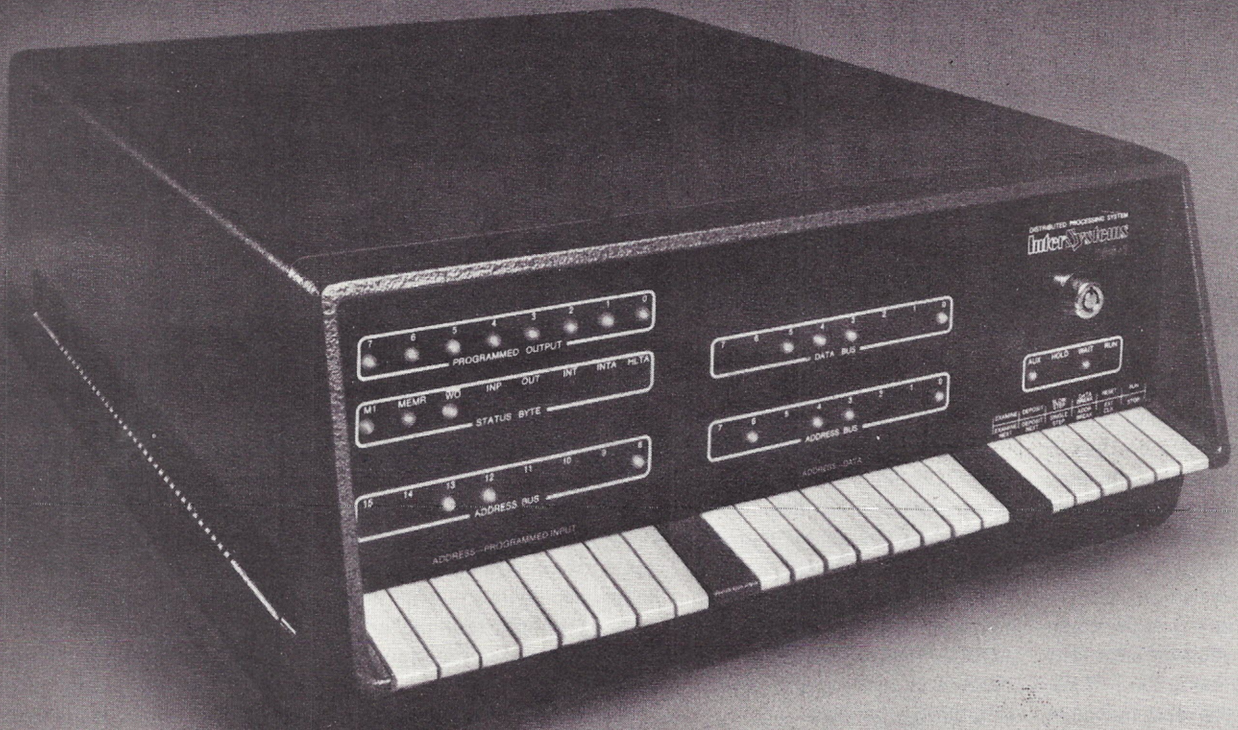

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AMI's EVK Series

Part 1: the introduction; part 2: the hardware; this time: the software.

This is the third and final article in my series describing AMI's EVK series single-board microcomputers. In part 1 I presented a general introduction to AMI and their products; part 2 described the EVK series hardware and configuration. This article will explain AMI's software support to the EVK.

PROTO ROM

The main operating system is called PROTO (prototype board monitor). This is supplied on all versions in the series from EVK 99 to EVK 300 in a 2K ROM. PROTO uses an ACIA to serially communicate with a TTY or RS-232 terminal. PROTO also uses an internal subroutine library called $(RS)^3$ for terminal input/output and some "number crunching" routines (more on this later). PROTO's starting address is F000.

The PROTO routines are called by entering a single-character command on the terminal. These commands may be followed by additional parameters, if needed, separated by commas or spaces. PROTO does not take action on the commands until it sees a carriage return, thus an error may be deleted by using the TTY ESCAPE key or the reset button. A description of each PROTO command follows.

PROTO Commands

L ADDL ADDH OFFSET (Load Tape command). This command loads data from tape into memory between address-low and address-high, inclusive. ADDL and ADDH are optional; if they're omitted, PROTO will use the starting address on the tape as a starting address. Also optional is the OFFSET value. If it is included, PROTO will add it to the address on the tape to form a new starting address for the tape data. This permits existing tapes to be patched into memory anywhere.

The OFFSET is a signed, two's complement number entered in hexadecimal. An offset of +8 is 0008, and −8 is FFF8 (all address and data values used in this article are in hexadecimal). If the offset is omitted, it is assumed to be 0000.

PROTO gives error messages in this and other commands. A BAD ADR displayed on the terminal indicates an attempt to load into nonexistent memory or ROM. A DELETE character at the terminal indicates an attempt to load beyond ADDL or ADDH. Finally, CKSM ERR indicates a checksum error occurring during the load.

P ADDL ADDH OFFSET (Punch Tape command). This command punches data from memory to tape between address-low to address-high, inclusive. Again, an OFFSET value may be used, and if left off is assumed to be 0000. Both Load and Punch commands are Motorola formatted, tape compatible.

E (End-of-Tape command). This last tape command will cause an end-of-tape record (S9) and a trailer tape to be generated. This is used immediately after the last Punch command and before the punch is turned off.

M ADDL ADDH DEST (Move Memory command). With this command the user may move memory data from range address-low through address-high, inclusive, to Destination. The memory may be from ROM or EPROM, and PROTO will display the BAD ADR error message if an attempt is made to load nonexistent memory

S ADDR BYTE1 BYTE2 . . . BYTEN (Set Memory command). This command allows direct hex entry of data from the keyboard into memory. Each line on the terminal requires an S address entry (for multiple line entries).

A space separator is used to identify valid user entries. If the user makes a mistake while setting memory, he can correct it by entering another byte instead of a space. PROTO will only accept the last byte (two characters). Only the last four characters are used with any of the commands in which you input an address.

D ADDL ADDH (Display Memory command). This command displays the data in memory locations between address-low and address-high, inclusive. Depending on the value of ADDL, up to 16 bytes are displayed on the first line. After PROTO displays address XXXF, a CR, LF is generated, and the current address and 16 more bytes are displayed per line to ADDH.

G ADDR (Go-to-Users-Program command). The G command starts execution of the user's program at the address specified by ADDR. If the user interrupts the program (by hitting reset), PROTO will save the current values of the MPU's registers in its scratchpad RAM. Pressing the reset switch twice will always ensure that PROTO initializes the stack before Going to a program.

R (Register Dump command). This command merely prints the current values in the user's CC, B, A, X, P and S registers

when the program was last interrupted.

B ADDL ADDH ROMADD (Burn EPROM command). This and the next three commands relate to EPROM programming. This command burns the data in memory locations address-low through address-high, inclusive, into the EPROM in the programming socket.

As with other commands discussed, the additional parameters are optional. If ADDL and ADDH are left off, the 512 bytes starting with FC00 (movable RAM in high memory) are used. Note that only one byte may be changed if desired. If ROMADD is left off, the least significant nine bits of ADDL are used.

In this command mode, PROTO executes both a "preverify" and a "verify" of each memory location. The preverify checks to see that each 0 bit required by the RAM byte is indeed 0 in the EPROM. Since bits can only be set from low to high (0 to 1), preverify will generate the following error message: the RAM address, the RAM byte (in binary), the EPROM byte in binary and the EPROM address (if L.S., nine bits different from RAM address). Verify, on the other hand, tests the EPROM after burning to ensure the data took. If not, the same error message with BAD ADR will be displayed. This EVK-300 PROTO command is extremely versatile since *any* bit in *any* EPROM memory location containing 0 may be set to 1.

I ADDL ADDH ROMADD (input EPROM to RAM). This command loads RAM with EPROM data. A user may modify a few bytes of programmed EPROM (burn lows to high). I have found occasion to leave a few memory locations open in an EPROM until I went further with my software development, then come back and complete the burn. Per previous discussion, the parameters following the I are optional.

V ADDL ADDH ROMADD. This command is merely a user-generated EPROM Verify (per the discussion in Burn above). Again, the error messages and optional parameters are the same. Example 1 shows the terminal display of some of PROTO's commands.

(RS)³ ROM

As previously mentioned, PROTO uses a subroutine library for some of its functions. While any system based on the PROTO operating system can access these routines in the PROTO ROM, this library may also be purchased on a separate ROM. (RS)³ is short for Re-entrant Self-Relative Subroutine ROMs (RSRSRS). These routines are called by entering an SWI (3F) and the subroutine's number forming a two-byte instruction. A user can almost consider these to be an extension of the 6800 instruction set.

left in the accumulators. The condition codes are set according to the result.

3F,08 ADDABX. The contents of AccA and AccB are added to the index register leaving the 16-bit sum in the index register.

3F,09 ADDAX. The contents of AccA are added to the contents of the index register, and the result is left in the index register.

3F,0A ADDBX. The contents of AccB are added to the contents of the index register, and the result is left in the index register.

3F,0B SUBXAB. The contents of the index register are subtracted from AccA and AccB, and the result is left in AccA and AccB.

```
>S 0180 0D 0A 04 4548 45 4C 4C 4F 20 42 4F 5A 4F 04
>S0100 CE 01 80 3F 12 3F 14 81 48 26 FA
>S010B 3F 14 81 49 26 F4 CE 01 83 3F 12 7E F0 41
>D 0180 018D
0180  0D 0A 04 48 45 4C 4C 4F 20 42 4F 5A 4F 04
>D0100 0118
0100  CE 01 80 3F 12 3F 14 81 48 26 FA 3F 14 81 49 26
0110  F4 CE 01 83 3F 12 7E F0 41
>P 0180 018D

S11101800D0A0448454C4C4F20424F5A4F0480
>P0100 0118

S11C0100CE01803F123F148148 26FA3F14814926F4CE01833F127EF0417D
>E
S9030000FC
>
>G0100

HELLO BOZO
>
```

Example 1. PROTO commands.

Following are the 24 routines with a brief description.

3F,00 PUSHALL. All registers are pushed onto the stack.

3F,01 POPALL. All registers are "popped" (pulled) off the stack.

3F,02 TXAB. The index register contents are transferred to AccA(MS) and AccB(LS).

3F,03 TABX. The contents of AccA(MS) and AccB(LS) are transferred to the index register.

3F,04 XABX. The contents of AccA(MS) and AccB(LS) are exchanged with the index register.

3F,05 PUSHX. The contents of the index register are pushed onto the stack.

3F,06 PULLX. The contents of the index register are pulled off the stack.

3F,07 ADDXAB. The contents of the index registers are added to AccA(MS) and AccB(LS) and

3F,0C SUBABX. The contents of AccA and AccB are subtracted from the index register, and the result is left in the index register.

3F,0D SUBAX. The contents of AccA are subtracted from the contents of the index register, and the result is left in the index register.

3F,0E SUBBX. The contents of AccB are subtracted from the contents of the index register, and the result is left in the index register.

3F,0F P2HEX. The byte pointed to by the index register is displayed in hexadecimal on the terminal. The index register is automatically incremented by 1.

3F,10 P4HEX. The address (two bytes) pointed to by the index register is displayed in hexadecimal on the terminal. The index register is incremented by 2.

3F,11 PRINTA. The ASCII character in AccA is output to the terminal.

3F,12 PMSG. A message string, pointed to by the index register, is output to the terminal. The string is terminated by ASCII EOT (hex 04).

3F,13 VALAN. A byte, pointed to by the index register, is examined to see if it is a valid alphanumeric character. If it is, the carry bit is set in the CC; if not, the overflow is set.

3F,14 INPUTA. An ASCII character is input from the terminal.

3F,15 CONHB. This routine scans memory, pointed to by the index register, for hex digits. If any are found, they are converted to a binary number (128 max) in AccA, and the carry bit is set. The carry is cleared, if none are found.

3F,16 INDEX. AccA is multiplied by AccB, and the result is added to the index register.

3F,17 MUL8. AccA is multiplied by AccB, and the result is left in AccA, AccB.

The condition code register is affected by these routines similarly to 6800 instructions. At this point, I might mention that PROTO uses a similar scheme with the SWI for breakpoints:

3F,80 Print Registers. This causes PROTO to display the standard CC,B,A,X,P,S register content format on the terminal and stop.

3F,81 Snapshot. PROTO will display the registers as above, but continue on with program execution.

MA/D ROM

As I mentioned in an earlier article, AMI's MicroAssembler Disassembler is the most convenient EVK series feature I have found. This can be an extremely versatile debugging tool as part of a larger system or the main assembler and documentation source on an EVK-only system. For ease of reading, I will itemize the main features and rules of the MA/D ROM and then refer to Example 2 to show how it's used.

1. Operands must be in hex and no more than four digits

long. The conventional hex prefix character ($) is *not* permitted.

2. No symbols can be defined or referenced.

3. Relative addresses are specified as *absolute* addresses. MA/D will assemble the offset value. An error message is given if the user exceeds the relative address limits.

4. Because no editor is present, no line numbers or comments are permitted.

5. MA/D is always at a current location, and all commands are entered after ADDR: (MA/D initializes with 002A:).

6. Command Summary.

@ ADDR (go to address). Causes MA/D to go to ADDRESS as its current location counter (always used after MA/D initialization to get to user's starting address).

$NN (disassemble instruction). Causes MA/D to disassemble NN number of instructions (NN = hex count). NN is optional; if left off, it is assumed to be an infinite count.

!ADDR (call subroutine). Causes MA/D to call a subroutine at ADDRESS. ADDR is optional; if it's left off, the current location is assumed.

"STRING (enter ASCII characters). Causes MA/D to assemble ASCII characters in successive memory locations beginning with the current location. An apostrophe instead of a quote sign assembles a *single* ASCII character.

&ADDRNN (move memory). Causes MA/D to move NN number of bytes from ADDRESS to current location.

= NN (hex display). Causes MA/D to display NN number of bytes in hex format.

```
A.M.I. 6800 MICRO ASSEMBLER/DISASSEMBLER - 1.0
(C) 1976, A.M.I.
002A:@0180
0180:0D 0A 04
0183:"HELLO BOZO
018D:04
018E:@0100
0100:LDX #0180
0103:3F 12
0105:3F 14
0107:CMPA #'H
0109:BEQNE 0105
010B:3F 14
010D:CMPA #$49????
010D:CMPA #49
010F:BNE 0105
0111:LDX #0183
0114:3F 12
0116:JMP FF41
0119:@01016
0116:JMP F041
0119:@0100
0100:$
0100-> CE  LDX    #0180
0103-> 3F  SWI
0104-> 12  12
0105-> 3F  SWI
0106-> 14  14
0107-> 81  CMP A #48
0109-> 26  BNE    0105
010B-> 3F  SWI
010C-> 14  14
010D-> 81  CMP A #49
010F-> 26  BNE    0105
0111-> CE  LDX    #0183
0114-> 3F  SWI
0115-> 12  12
0116-> 7E  JMP    F041
0119-> F4  AN
>G0100

HELLO BOZO
>
```

Example 2. MA/D commands.

7. Hitting the terminal's RETURN key at the current location will cause that location to be disassembled.

8. Data may be entered in hex at the current location.

Example 2 shows a typical use of MA/D. After PROTO's prompt, I entered GE802 (MA/D's start address). MA/D gives the heading (an irritant on a TTY) and the initial current location counter. I then entered @0180 to get to my first starting address. Next I entered two message strings: the first in hex immediately (CR, LF, EXT) and the second as ASCII characters.

I then entered my program at a new start address (@0100). I made three mistakes:

1. At 0109 I corrected the BEQ by hitting two ASCII back spaces (not echoed, unfortunately) and then NE. This made 0109, BNE 0105.

2. At 010D I entered the hex prefix ($) before the data. MA/D asked "????" and retyped the current location. I then made the correct entry.

3. At 0116 I completely entered the wrong value, so I directed MA/D back to the location.

When the program was complete, I had MA/D give me a disassembly of the routine, then I hit reset to go back to PROTO.

Conclusion

That concludes my discussion of the AMI EVK series. I've given my EVK system a lot of use, with *no* problem in the past 18 months. It's a reliable system, and I haven't found any bugs in either the hardware or software. I highly recommend it for any serious 6800 machine-language user, hobbyist or company making its first microcomputer venture. ■

How to Choose a Small-Business Computer

In this particular case history, the equipment that eventually was selected was less important than the methods that were utilized to make the decision.

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This article was written primarily for small-business and professional people who are considering the purchase of a computer system. However, others interested in the purchase of a computer will find this information equally helpful and interesting. Once you have read this article you will be able to step forward with new knowledge and understanding in your quest for a computer system that will meet your particular needs.

This article is based on actual experience in the areas of hardware acquisition and hardware and software implementation. Examples to be given here are taken from the recent and actual implementation of a computerized billing system for the Leesburg Christian School in Virginia (see Photo 1).

Introduction

In this age of computers, you, as a business or professional person, have probably already considered (or at least mentally speculated on) the implementation of a computer system for your particular needs. However, and unfortunately, these processes are often turned off by the unanswered questions and mysterious terminology sometimes associated with the new breed of small-business computer systems.

While following the course taken in this real-life experience, you will be exposed to the process of business-need determination, or "Do I need a computer?" Also, discussion on system selection and hardware selection will be aired. These two terms seem similar in meaning, but you will find that they are quite different. The question of hardware implementation will be discussed using our example and generalizing where necessary and helpful. Two other items that seem to be synonymous but are not are the selection of software, or software needs, and the determination of program needs, or "What specific programs must be written to support the system?"

Next, there will be a discussion on writing programs using some of the programs written for the previously mentioned billing system as examples. These examples may serve to illustrate more vividly what you might expect from your computer system. Finally, an overview of the practical, everyday operation of our example system will be given, summarizing the hardware and software features of the system. We trust that you will find this information both informative and interesting.

Business Need

In the case of our implementing the system under study, the computer became necessary as the result of an apparent need to streamline the school billing system. The goal was to obtain prompt and accurate billing followed by past-due reminders when necessary. We anticipated improved commuication and understanding between the school and the parents.

You might note the stated premise: The need was apparent and the computer became the means of solving the problem. This may sound elementary, but you would be amazed at the number of people who approach the problem from the other end, that is, they purchase the computer first and then attempt to apply it to some aspect of their business or occupation, often with poor results. In these cases the com-

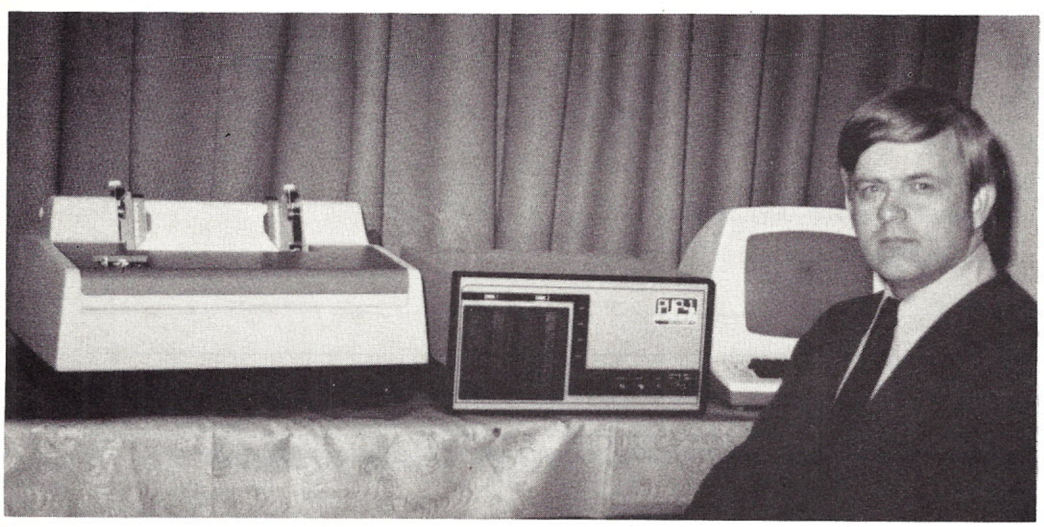

Photo 1. Author in the computer room.

puter was probably needed, but lacking the application of "the apparent need" to the purchase decision, the purchaser was unable to tailor the system to the actual need.

While the statement made in a recent computer advertisement that "You can afford a computer if you can afford a new delivery truck" is probably true, it does not necessarily follow that you should buy a particular computer just because you can afford it; rather, you should buy a computer because you need it and have previously determined its usefulness. Study the market and find the computer system that will do the job for you based on your needs. In this way, you will best serve yourself, your company and your customer.

The school under discussion had a problem that is common to many small businesses: relatively high volumes of material to be processed, but not enough time and too few employees to devote to such work. As we shall see, the computer, through proper planning and implementation, produced the desired results.

While thinking about a computer for your application, you might ask yourself the following questions: Is there some area of the business that I do not feel comfortable about? Is billing a problem? Should the mailing system be automated? If the answer to these questions is yes, then these are areas where a computer may prove useful.

Do you have the need to perform repetitive tasks and to store large amounts of information with the need to retrieve data from or change data in the stored information? Do you store lists and then require printed information from these lists? Do you need the flexibility of producing custom-printed materials in moderate volumes? Do you need to visually examine stored data without the time-consuming file room search? Are there other areas where an organized input, storage, processing and output or printing of data is required? If so, then a computer can probably be put to good use in your operations.

Let's not forget the in-house use of computers to aid in the tasks of design, research and development, quality control and production applications. By now, this food for thought has probably led you mentally to the computer dealer; but wait, we have just begun.

System Selection

System selection is here defined as selecting a system to meet the need. As we discussed previously, system selection is dependent on the ultimate need and use for the system. Here again, this may seem elementary, but let us look at a few examples of what we mean by this.

If you intend to obtain printed reports from your system, then a printer will be required; the printer line width, speed and print style will be determined by its ultimate use in the system. If you intend to write form letters with your computer, then a printer with both upper and lowercase letter capability will be required. If you plan to store large volumes of data, then storage media such as a disk system will be required for the system. If you intend to have full capability to enter, update and view quantities of material in your final system configuration, then a video terminal, as opposed to the slower-printing terminals, will be desirable.

The size of your programs and the handling of your stored files will determine the amount of RAM memory that you will have to have resident in the computer. And finally, the combination of all of these items will determine the type, number and structure of your I/O devices.

As you can see, it would be a mistake to oversimplify the requirements of a computer system when selecting it for business applications. The purchaser of a computer for business applications should not be unduly attracted by the "complete" system, without first examining every aspect of its operation in relation to its intended use. It would be more

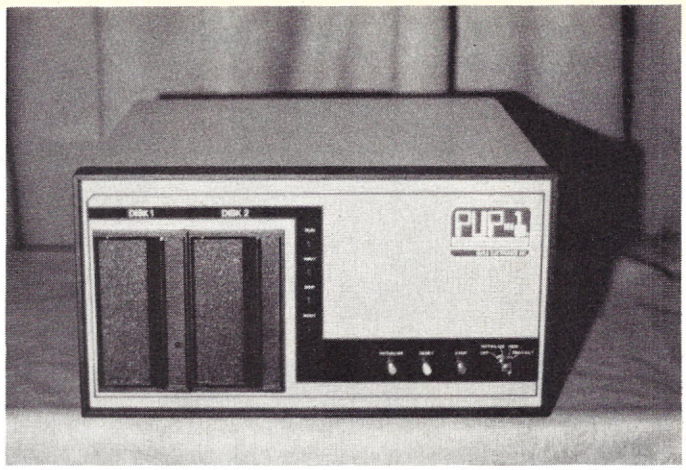

Photo 2. The PUP-1 Microprocessor by Seals Electronics.

than a little disturbing to unveil your newly purchased system only to find that the printer carriage will not accept the required forms or that the speed of the overall system is so slow that your grandmother can write the bills faster than your new computer.

The selection of a system for the school billing system here being discussed was done using the aforementioned principles. First, it was determined that the storage of large quantities of information in a master file on disk media would be necessary and that from these master files all of the subsequent operations would be performed. From this basic information and a projection of anticipated individual file size, it was determined that a dual 5 1/4 inch floppy-disk system would be desirable.

The next step was to determine the amount of random access memory that the computer should contain for program use. It is not uncommon for a complex program to be 6 or 8K bytes (characters) long. This, coupled with the basic language software size of from 12 to 20K bytes in length and the need for a moderate amount of space to accommodate data from the disk files, gives us a requirement of about 40K bytes for conservative business use. Note: Purchasing memory is no longer the financial nightmare that it was a few years ago, and since memory is one of the greatest assets to your system's flexibility, be sure that you have enough.

The next most obvious need is for the terminal to be used to input data to the computer and receive data from the computer. The most common conception is that of a video terminal or CRT terminal, whichever you wish to call it. However, it can be anything from a series of switches on the front panel of the computer to a printing terminal such as the Teletype Model 33 to the video terminal.

To determine the terminal requirements for the school system, it was necessary to study the process to be implemented. First, the computer operator would have to enter large amounts of data. Next, provision would have to be made for the operator to examine individual files in order to make changes, such as crediting monthly tuition payments, address changes and other needed changes to individual records.

Furthermore, a visual display of the contents of individual files was desired for informational purposes to answer outside inquiries and to satisfy internal needs. Speed and noise were also considered in the deliberations. The video terminal closely matched the requirements for this particular application and was therefore chosen as the I/O device.

Equally necessary to a billing system is the line printer, and its capabilities, as with the other pieces of hardware, have to be tailored to the needs of the system. Since there would

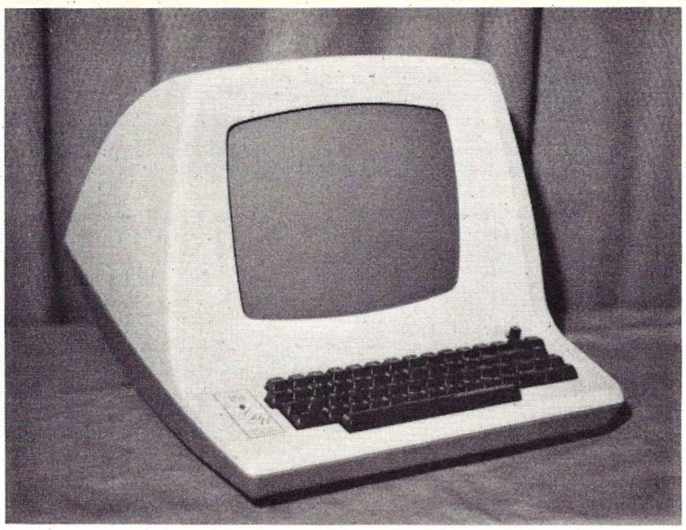

Photo 3. The Lear Siegler ADM-3 video terminal.

be no need to use the school system for word processing, which would require the use of upper and lowercase characters, it was decided to use the faster dot-matrix-type printer with uppercase only.

Another requirement was the ability to type characters of differing sizes so that forms could be produced for the school's use. Since forms of various sizes were in view, the printer would have to be equipped with adjustable sprocket feed as opposed to the friction-feed mechanism found on many printers. Speed was not considered to be a critical factor in the selection of the printer as long as moderate speed was obtained.

Having thus outlined our needs, we will proceed with the selection of the actual hardware.

Hardware Selection

We have now reached the point where all previous study and planning come into play, that is, the selection of the hardware that will be used in the system. Here, caution must be exercised; a mistake made here will be remembered for a long time. Not only is the expenditure made at this time but service agreements are made, and these agreements have to be satisfactory in the event that you have some problems with the equipment in the future.

Experience has shown that high reliability can be expected from the experienced manufacturer. Furthermore, assembled equipment generally requires less attention initially than does equipment purchased in kit form. However, the possibility still exists that you will have a component failure, so be sure that you can count on the manufacturer or agent to back up his equipment with reasonable service.

Additionally, service contracts can be purchased to cover service on the equipment beyond the limits of the original sales agreement. You will probably consider this type of extended service to be desirable, unless you have the facility to perform your own service work. Remember: service over the long haul will be necessary to keep your equipment in top operating condition.

One of the things to look for when selecting hardware is the type of software provided with the computer (if any). Also consider standard features, such as I/O facilities, RAM memory, ability to expand without modification and the inclusion of diagnostics such as an operating system to allow the system to be checked without extensive equipment.

The first piece of hardware selected for the school system was the computer, or microprocessor. Several excellent systems were analyzed using the criterion established under System Selection. Of the systems considered, the one that most closely met the specified requirements was the Seals Electronics PUP-1 microprocessor. Seals Electronics has a reputation for dependability and is probably best known for their memory modules and various other computer products.

The PUP-1 microprocessor is a compact unit that contains two mini-floppy disk drives (see Photo 2). It has a conservatively rated power supply and an eleven slot S-100 bus card cage that is removable for service if necessary. Other standard features include 32K bytes of RAM memory expandable to 0.5 megabytes, three I/O ports and the popular Z-80 central processing unit. The rear panel has provision for additional 12, 25 and 37 pin connectors if needed for expansion. Also mounted on the rear panel directly behind the card cage is a 115 cfm fan to provide proper cooling for all circuitry.

The front panel is simple and functional, consisting of a four-position key switch designated off, initialize, run and protect and three push-button switches designated reset, initialize and stop. Additionally, four LED indicators are used to indicate the processor states of run, wait, input and output. Mechanically, the unit is rugged; it is contained in a desk-top enclosure measuring $17 \times 8.75 \times 17.5$ inches deep and has a rigid sub-chassis on which all electrical components are mounted, except for the front and rear panel assemblies.

As we mentioned earlier, the system software is an important consideration when hardware is purchased. This particular system came with an extended BASIC language, a disk operating system and a diagnostic monitor as standard software. The monitor is activated by pressing a button on the front panel, and since it resides in ROM, it responds instantaneously. The other software is provided on a 5 1/4 inch floppy disk and is also called by pushing a front panel switch.

The next step was to select a video monitor that would meet the needs of the system. Once again, many fine terminals were available, and almost any imaginable features can be had if you want to spend the money. However, for our purposes, we selected the Lear Siegler ADM-3 video terminal (see Photo 3).

The ADM-3 is an attractive and functional terminal; it has a full 59-character ASCII-encoded keyboard offering all of the necessary control functions. The screen is a 12 inch (diagonally measured) rectangular CRT with P4 white phosphor and non-glare surface. The screen output format selected was the full 1920 character screen, giving 24 lines of 80 characters each. The characters are displayed in a readable 5×7 dot-matrix configuration. New data typed appears on the bottom line of the screen, and the line feed causes an upward scrolling of the entire display.

Computer interfaces provided include standard RS-232 operation and 20 mA current loop operation (switch selectable). Also included is an extension interface to allow RS-232 operation of an auxiliary printer, modem or an additional terminal. Standard baud rates from 75 to 19,200 baud are switch-selected from the front panel, as are the various terminal configuration options. Since our need was primarily for a point-of-entry and operational terminal, the ADM-3 supplied all that we needed.

We then focused our attention on the remaining hardware need, that of the line printer. Without exception, all of the printers that are suitable for business use are manufactured by nationally recognized firms, and they are all of high quality.

To meet the specified requirements of the school computer system, we selected the Centronics 306c (see Photo 4). The 306c has been described as a workhorse in the Centronics line of printers. It is a ruggedly constructed sprocket or pin-feed printer with the capability of providing four different type formats: the normal 5×7 dot matrix provides 80 characters per line; the elongated (double width) format provides 40 characters per line; the condensed format provides 132 characters

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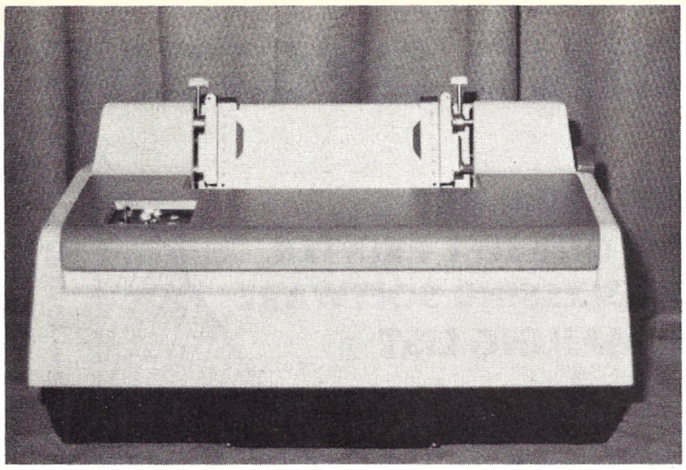

Photo 4. The Centronics 306c printer.

per line; and the condensed/elongated format provides heavily accented characters at 80 per line (Example 1).

All of these formats are software-controlled, as are the printer select and deselect functions. Manual controls include an on/off switch, a select switch with light indicator, a switch for selection of normal or condensed print and a forms-override switch allowing push-button operation of either single line feed or form advance (one preset form length). Form width is adjustable from 1 1/8 to 9 1/2 inches to allow for differing paper width and mailing labels.

The printer also features an audible bell indicator that sounds when the paper runs out. This also freezes operation so that you may replenish the paper supply and continue printing without missing a character. The print quality in all formats is excellent. The optional RS-232 interface board was selected to allow convenient installation in the system.

Hardware Implementation

As was noted in the previous section, the computer included several I/O devices as a standard feature. The video terminal was also equipped with its I/O options, as was the printer. The software operating system supplied with the computer was well suited to I/O applications, since it is possible to customize the software to recognize any combination of peripheral equipment.

The first step was to customize the software to recognize the video terminal as the normal I/O device and the printer as the second output device. In this way, the computer would always respond to the video display keyboard and would ignore the printer unless instructed through software to print data.

The next step was to mold these three pieces of hardware into an operational system. The decision had been made to use the two RS-232 I/O connections in the computer since they were assigned as the operating ports in the ROM diagnostic monitor; in this way, the monitor would remain a vital part of the system. Hookup to the video terminal was effortless, since all of the terminal options could be adjusted from the terminal's front panel. All that remained was the attachment of the connecting cable. A preliminary test using the monitor indicated that all was OK.

It should be noted here that the inclusion of the diagnostic monitor in the computer is a convenient feature, since you have at your disposal a means of checking your system without relying on the input of data from an unverified source of hardware.

The installation of the printer is somewhat more complicated, but is considered typical of what you can expect when interface time rolls around. A brief description follows.

As mentioned previously, the computer has two serial RS-232 ports for I/O operations. It was also noted that the diagnostic monitor is immediately available to the I/O ports. This means that the I/O configuration for the monitor is preset at the factory. There was no problem with the video terminal since the configuration could be set on its own front panel switches. However, the printer was wired for a configuration other than that used by the monitor.

Seals Electronics anticipated this problem when they designed the computer. The I/O configuration of the RS-232 ports can be set under software control to any standard RS-232 configuration.

After we determined the printer-port characteristics, a software initialization was used to set the I/O port prior to printer use. In this same way the I/O ports on the computer can be used on any piece of equipment utilizing RS-232 I/O port options. Printer operation was checked by loading BASIC via the integral floppy-disk system and performing several basic print routines to exercise the various print formats available from the printer.

At this point, all aspects of the system were checked for proper operation. This is essential to ensure that you do not labor for hours, or even days, only to find that some initially undetected problem has destroyed your work. In these tests the example system performed without problem.

Software Needs

The software needs of any system are dependent to some extent on the hardware. For example, if you have a disk system, then you will need software capable of handling disk formatting, copying, reading, writing and other utilities associated with the proper upkeep of disk records. If you will be using several external devices, your software will need the capability of handling multiple I/O devices. If you intend to write programs in assembly language, then you will need special software for this purpose.

In addition to hardware considerations in selecting software, you also have to consider the intended use of the software and its ultimate use in the system. If, for example, you desire to use your system to print various forms or to output specified data to the printer, then you will need a high-level language, such as BASIC, that has the capability to format the printer output within the software, allowing you greater latitude in program construction. If your need is for word processing, or the processing of the written page, for the purpose of writing reports or form letters to be printed in perfect form at a later time, then you will need special software for this application.

Since it is impossible to consider all of the possibilities that may exist for the individual system, let us indicate here that your system will be limited to the capability of your software

```
NOW IS THE TIME FOR ALL GOOD MEN TO COME

NOW IS THE TIME FOR ALL GOOD MEN TO COME TO THE AID OF THEIR PARTY

NOW IS THE TIME FOR ALL GOOD MEN TO COME TO THE AID OF THEIR PARTY

NOW IS THE TIME FOR ALL GOOD MEN TO COME TO THE AID OF THEIR PARTY
```

Example 1. The four print formats: from top to bottom, elongated, condensed-elongated, normal and condensed.

to perform the intended task, so the same care and consideration should be exercised here in the selection of the system software that was exercised in the selection of the hardware.

The software needs of the school system were met by the software that was included as standard with the computer system, that is, the North Star Disk Extended BASIC and disk operating system supplied on floppy disk and the Technical Design Lab's diagnostic monitor installed in ROM.

Program Needs

The software selected in the previous section is general in nature and, therefore, can be used with various hardware systems. It can also be tailored to do numerous jobs; however, even with this great potential, when you turn the computer on it just sits there waiting for you to tell it what to do. If you don't provide intelligent input to the computer, it will not perform for you.

We now direct our attention to writing application software, that is, software programs written in the previously chosen language. These programs will transform the computer from the blinking and buzzing mass of inanimate potential into the useful and desirable tool that was mentally pictured when we first considered its use.

There are three approaches that may be used to obtain the needed programs. The first is to write the program yourself. This is theoretically the best method since it will provide you with the exact custom requirements for your system. After all, who knows your problem any better than you do? And since the process of programming deals with every dollar sign, comma and period individually, you are right there to ensure that they are properly dispatched.

However, as desirable as this may seem, there are several drawbacks. Who will provide you with the time and inclination necessary to master the given computer language and then write and troubleshoot the programs? This can be an enjoyable experience, but it will consume much time and an equal amount of patience, not to mention a certain aptitude for numerous and minute detail.

The second approach is to purchase packaged software programs from a vendor. Normally, these packages are given titles such as Accounts Receivable, Billing, Mailing and so on. While it may seem that you are able to match the title to your specific need, you will find that these programs will require modification in order to run in your system, and/or they will require format changes to meet your specific needs. However, these software packages represent a reasonable solution to your system programming needs if you can find a good one that meets your specifications, since they are reasonably priced due to their mass production. Here again, if you expect to do the implementation yourself, you must be prepared to participate as described in the first approach.

The third approach to the problem is to have custom programs written for your system needs. This method provides for most of the benefits of the first approach, that is, it provides you with the programs written to your specifications and ready to run in your system. This method is more expensive than the packaged software, but may prove to be the most popular due to the lack of user involvement.

Once you decide the question of the approach to be used to obtain the programs, you must decide what specific programs will be required to implement the system. This is not a complicated process; it is based on your needs and preferences. For example, in the school system, it was decided to store all of the necessary information in what we will refer to as the master file. From this file (on floppy disk) all of the other functions would be performed. This master file would contain the data to be retained for the permanent record, as well as the debit and credit billing information.

Furthermore, it was decided

that the following functions would be needed to implement the system: First, a means of modifying data in the master file to enter payments and to make corrections as needed. Second, a means of producing the actual billing on a monthly basis from the stored data. Third, a means of isolating and processing past-due notices for delinquent accounts. In addition, it was decided that mailing labels would be produced from the master file, as well as an alphabetical telephone directory listing and a name and address listing based on account number and/or last name priority. Finally, the computer would produce forms to be used for gathering initial data for the master file.

As you can see, we have reached the point in this process where we are able to express ourselves in terms of what we actually expect the computer to do for us. This is the same mental exercise that we went through when we originally thought that the computer might help us, and now we will expand those thoughts into the details of our final programs.

Writing Programs

Since writing programs is a specialized art, and the variables associated with it are too numerous to do justice to at this writing, this section will be devoted to a verbal discussion and description of the actual school programs. This process will familiarize you with the structure of programming in general and will be helpful, since it will provide you with information that may be used to determine the structure of your own programs.

The first program segment written was designed to construct the master file on floppy disk. It was written so that the computer would provide prompting questions on the CRT terminal for all data to be entered, thus reducing the possibility of an incorrect entry. When all of the data is entered for a given file, the program automatically places the data on the floppy disk and then continues the program by asking for information to be input for the next file.

```
**** SCHOOL ACCOUNTS RECEIVABLE AND UTILITY PROGRAM ****

          PLACE DATA FILE IN DRIVE # 1
          PROGRAM FILE IN DRIVE # 2

TYPE -C- TO CONTINUE  .....C

          WHAT DO YOU WISH TO DO ?

     1---PRODUCE STUDENT DATA SHEETS (FORMS)
     2---ENTER STUDENT DATA IN MASTER FILE
     3---MODIFY DATA IN MASTER FILE
     4---PRINT MONTHLY BILLING
     5---PRINT PAST DUE NOTICES
     6---PRINT MAILING LABELS
     7---PRINT ACCOUNT NO. AND NAME LISTING
     8---PRINT ACCOUNT NO. AND LAST NAME LISTING
     9---SORT ALPHABETICALLY AND PRINT LISTING
     10--NOT ASSIGNED
     11--NOT ASSIGNED
     12--STOP

TYPE THE NUMBER CORRESPONDING TO THE DESIRED ITEM  =.....
```

Example 3. Typical prompting sequence from the selection program segment as viewed on the computer's terminal.

The program was designed for each individual file to contain the following information: account number; name; address and phone number of the parent; name, grade and tuition information for each student, including registration, insurance, miscellaneous and comments when needed. Provision was made for five possible students per family (file). The master file also stores the necessary credit and debit information and the accumulative totals of all payments on an individual file basis.

When this program segment is run, it automatically scans the existing records on the floppy disk, determines the location of the last file entered and then asks the operator for input to the next sequential file. When input to the files is completed, the program is automatically terminated by the computer.

The next segment written was designed to allow modification to the master file described above. This segment is also self-prompting. It allows for the modification of the complete file or any item within the file, such as the spelling of a name, an address correction, a changed phone number or whatever. One of the main functions of this program segment is the entering of the monthly payment data to be used in the billing process.

Remember, all of the functions described here interact with the permanent master file record on the floppy-disk storage media; consequently, each process culminates with the desired data being recorded on the floppy disk. The diskette is then ready to be stored until the next usage.

Now that the facilities for the construction and modification of the master file have been considered, our attention is turned to the actual billing process and its associated program segment.

As written for the school system, the billing of accounts can be done at any time, and when the billing is done it will reflect the current status of the master files. The billing program, first, enters the master files, transfers the needed information to the computer's RAM, prints the actual bill via the printer, adjusts the files in RAM to reflect the printed billing and then modifies the master disk file so that it too reflects the current

```
                LEESBURG CHRISTIAN SCHOOL
                   STUDENT DATA SHEET
NAME
MR. & MRS. ETC.     FIRST NAME        MID NAME         LAST NAME

ADDRESS
NUMBER       STREET NAME       TOWN        STATE       ZIP CODE

TELEPHONE NO.

        AREA CODE          NUMBER

STUDENTS
  FIRST NAME       MID INITIAL      GRADE        MONTHLY TUITION
#1                                              $
#2                                              $
#3                                              $
#4                                              $
#5                                              $
****************************************************************
TOTAL MONTHLY TUITION                           $

REGISTRATION FEE                                $
LATE CHARGE                                     $
OTHER CHARGES                                   $
NATURE OF OTHER CHARGES  :
CREDIT                                          $
CREDIT DATE                                     :
NATURE OF CREDIT  :
COMMENTS  :                                                  1
```

Example 2. Form produced by the computer as an aid in gathering information for the master file.

information. All of the above are done automatically; the operator merely follows the prompts displayed on the CRT terminal to complete the process.

It may be interesting to note that the forms selected for this billing system are the quick-mailer type, that is, the forms are complete and self-contained, similar to the familiar W-2 Tax envelope. This is convenient since the file copy, envelope and contents are all printed at the same time. When the billing run is complete, you merely separate the various parts, place a stamp on the envelope and mail it. It should be noted that these particular self-mailers were blank, and the computer was used to print the form format as well as the current billing data. This was possible due to the versatility of the printer formatting as described earlier.

Next, our efforts are directed to the servicing of past-due accounts. Two functions are implemented here. First, this program segment can be directed to print a listing of past-due accounts. To perform this function, the program enters the master file stored on the floppy disk, searches for the specified data, returns the data to the computer and prints the listing of past-due accounts. This listing includes the account number, amount due, amount paid, if any, and the total amount past due.

Second, the command can be given to print past-due notices. In this case, the computer goes through a similar process that ends with the printing of the notices by the line printer. Quick-mailer forms are used for the past-due notices. However, in this case the forms are pre-printed, so the computer is required to print only the billing data and not the form format as with the regular billing cycle.

Several other program segments were written to provide various desired functions. First, an alphabetical name and telephone listing was produced to provide the school with a directory. Second, a segment was written to produce mailing labels from the master file to expedite the mailing of periodicals to the parents. Finally, two segments were developed to provide listings, first, by account number and, second, by last-name priority.

The last program segment to be written was designed to produce forms for gathering data for the master files (Example 2). Here again, we note that the software-selectable print-format capability of the printer allows the production of forms and other printed matter that require various-sized print.

Upon completion of all of the component parts of the system, a final program was written to tie all of the segments together. We will refer to this as the selection program. This program allows the selection of any of the previously mentioned segments via the CRT terminal and without further manipulation by the operator. For example, when the select program is run, it will ask you what you want to do and then it will list your options: 1—Produce Student Data Sheets, 2—Enter Student Data in Master Files, 3—Modify Data in Master Files, 4—Print Monthly Billing, 5—Print Past-Due Notices, 6—Print Mailing Labels, 7—Print Account Number and Name Listing, 8—Print Alphabetical Telephone Listing, 9—Stop.

After selection of the desired function, you simply type the number corresponding to that function on the terminal keyboard; the selection program will then load and automatically start the desired program segment. When processing is completed, the computer will return to the selection program, so that processing may continue if desired.

As was mentioned earlier, all of the functions of the school program were designed to be self-prompting, that is, all of the information needed to complete any given operation is requested by the computer during the actual running of the various programs. Also, error messages are included at critical points along the way.

For example, when the diskettes are placed in the computer and processing of the master entry program begins, the program first checks to determine that the diskettes are properly placed in the computer. If they are not, a message will be given to correct the placement of the diskettes and begin again. When your programs are written in this manner, the computer can be operated by various individuals with a minimum of training required.

Summary

Once your program writing is finished, the computer should function in a concise fashion. To illustrate this, let us follow the actual operation of a typical billing cycle (Example 3). We will assume that the initial master file data has been entered and the billing cycle is under way. Furthermore, we have received the normal monthly account payments, which are ready to be entered in the computer.

Start the computer by pressing the run button, which initiates the loading sequence. With this particular computer/software combination, all loading is automatic. The first thing that the operator sees is the question from the selection program regarding the proper placement of the diskettes in the computer. After the diskettes are properly placed, the program continues by asking you what you want to do and presenting you with the previously described options.

In this case, the option selected would be to modify data in the master file (enter payments). Upon receiving this request, the selection program goes to the program file on diskette and selects the proper program segment, loads it into the computer memory and starts the program.

The next thing that the operator sees on the screen of the CRT terminal is the question, "What account do you wish to modify?" followed by the request to type the appropriate account number. After the operator types the account number, the new program takes over and activates the disk drive to search for the account number in the master file. Upon finding the proper account number, the program returns the data for that file to the computer's memory and displays the file contents on the CRT screen. The operator then selects the portion of the account to be modified, in this case, the credit portion. Payment and payment date are entered; the program continues by asking if other modifications are required to

```
ACCOUNT TO BE MODIFIED = # 8129


JONES SALLY P.

1-MARITAL STATUS                   2-FIRST NAME & MID. INITIAL
3-LAST NAME                        4-STREET NUMBER ONLY
5-STREET NAME                      6-TOWN
7-STATE                            8-ZIP
9-TELEPHONE NO.                    10-STU#1, FIRST NAME INITIAL
11-STU#1, GRADE                    12-STU#1, MONTHLY TUITION
13-STU#2, NAME & INIT.             14-STU#2, GRADE
15-STU#2, MONTHLY TUIT.            16-STU#3, NAME & INITIAL
17-STU#3, GRADE                    18-STU#3, MONTHLY TUITION
19-STU#4, NAME & INIT.             20-STU#4, GRADE
21-STU#4, MONTHLY TUIT.            22-STU#5, NAME & INITIAL
23-STU#5, GRADE                    24-STU#5, MONTHLY TUITION
25-REGISTRATION FEE                26-LATE CHARGE
27-OTHER CHARGES                   28-NATURE OF OTHER CHARGES
29-CREDIT(PYMT.)                   30-CREDIT DATE
31-NATURE OF CREDIT                32-COMMENTS

ENTER NUMBER CORRESPONDING TO ITEM TO BE CHANGED 32
CHANGE : BILL-ON THE 20TH
TO : BILL-ON THE 15TH
 ARE MORE CHANGES REQUIRED TO THIS RECORD ? NO


ARE CHANGES REQUIRED TO OTHER RECORDS ? NO
```

Example 4. File modification sequence. A change was made to the item comments.

```
BEGINNING FILE NUMBER   : 8000
NUMBER OF FILES   : 50
DATE   : 2-16-79
DUE DATE    : 2-15-79
TYPE A PERIOD FOR ALIGNMENT, PRESS SPACE BAR TO BEGIN

              ACCOUNTS PAST DUE      2-15-79

 8000 \ PREV. BAL.   $131. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $131. 00
 8001 \ PREV. BAL.   $151. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $151. 00
 8005 \ PREV. BAL.   $131. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $131. 00
 8006 \ PREV. BAL.    $53. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE     $53. 00
 8008 \ PREV. BAL.   $261. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $261. 00
 8009 \ PREV. BAL.   $136. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $136. 00
 8013 \ PREV. BAL.   $131. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $131. 00
 8015 \ PREV. BAL.   $108. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $108. 00
 8016 \ PREV. BAL.   $508. 92 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $508. 92
 8017 \ PREV. BAL.   $161. 78 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $161. 78
 8019 \ PREV. BAL.   $174. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $174. 00
 8023 \ PREV. BAL.   $131. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $131. 00
 8025 \ PREV. BAL.   $230. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $230. 00
 8026 \ PREV. BAL.   $131. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $131. 00
 8027 \ PREV. BAL.   $131. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $131. 00
 8028 \ PREV. BAL.   $267. 40 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $267. 40
 8031 \ PREV. BAL.   $309. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $309. 00
 8033 \ PREV. BAL.   $262. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $262. 00
 8034 \ PREV. BAL.   $136. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $136. 00
 8035 \ PREV. BAL.    $99. 50 \ PYMT .            $. 00 \ AMOUNT PAST DUE     $99. 50
 8037 \ PREV. BAL.   $140. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $140. 00
 8039 \ PREV. BAL.   $140. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $140. 00
 8040 \ PREV. BAL.    $53. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE     $53. 00
 8041 \ PREV. BAL.    $53. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE     $53. 00
 8042 \ PREV. BAL.   $136. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $136. 00
 8043 \ PREV. BAL.   $136. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $136. 00
 8044 \ PREV. BAL.    $53. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE     $53. 00
 8049 \ PREV. BAL.   $136. 00 \ PYMT .            $. 00 \ AMOUNT PAST DUE    $136. 00


ANOTHER COPY ? : NO


DO YOU WISH TO CONTINUE PROCESSING ? :NO
READY
```

Example 5. Program procedure for listing past-due accounts without printing reminders.

that particular account. If not, the program writes the new data to the master file on floppy disk (see Example 4)

Next, the program asks the operator if he wishes to enter other files. If not, the computer returns to the selection program and asks the operator how he wishes to proceed by presenting the selection list described earlier (see Example 3).

Assuming that all credit data for the period has been entered and that the operator wishes to prepare the bills, the "Print Monthly Billing" segment will be selected from the selection program listing. After receiving this command from the operator, the selection program begins by loading the proper program segment and starting the program. The new program obtains the required data from the master file and continues by printing the current individual billing data on the quick-mailer forms described earlier. In addition to printing the actual form headings, the billing program prints the name, address, previous balance, current charges and total due or credit for the addressee and the name and return address of the sender.

Once the actual bill is printed, the billing program automatically adjusts the master file to reflect the billing entries. When the billing run is complete, the master file diskette is removed for safekeeping until required for further processing.

When the past-due date rolls around, the system is activated to process the accounts that have not paid on time. If you wish to examine the past-due accounts without printing reminders, this can be executed as a separate listing. Account listings can be printed at any time to determine the status of payments and debits (see Example 5).

The printing of the past-due notices is initiated in the same way that the billing program was initiated, except that the response to the selection program query would be the selection of the option to "Print Past-Due Notices." Once the command is given, the selection program loads and starts the past-due program segment. The program begins by asking for the parameters involved, such as beginning file number, date, due date and so on.

Next, the program enters the master file and obtains only those records that are past due. It computes the desired penalty, applies the penalty to the past-due amount, prints the actual bill and then makes the necessary corrections to the master file on diskette. If the past-due amount is not paid within the prescribed time, the past-due amount and the penalty will be carried forward and will appear as a previous balance on the new monthly billing. A sample past-due notice from the school system is shown in Example 6.

The other functions of this system are initiated and perform in a manner similar to that already described, that is, with a minimum of operator involvement. Naturally, the operator will have to be aware of the various types of forms and their proper insertion in the printer; but aside from that, the computer controls the program operations through the prompts associated with each program

LEESBURG CHRISTIAN SCHOOL
212 SOUTH KING STREET
LEESBURG VIRGINIA 22075

2-16-79

PAST DUE NOTICE

Your remittance by return mail will be appreciated.

THANK YOU!

If payment has been made, please disregard this notice.

ACCOUNT NUMBER	AMOUNT OF PAYMENT PAST DUE	DATE DUE MO. DAY YEAR	LATE CHARGE AMOUNT			TOTAL AMOUNT DUE	PAY TOTAL AMOUNT AFTER THIS DATE
8129	$270. 00	2-15-79	$13. 50			$283. 50	2-25-79

MR & MRS JOHN P. JONES
2222 WATER STREET
BAYSIDE VIRGINIA 22075

SPECIAL NOTE:
YOUR PAYMENT WAS DUE ON THE
15TH OF THIS MONTH. TO AVOID
LATE CHARGES, PLEASE PAY THE
AMOUNT SHOWN BY THE 25TH.
---------THANK YOU---------

Example 6. Past-due notice from the school system. The file copy is shown.

The InterTube II Video Display Terminal is truly representative of the latest state-of-the-art advances in microprocessor technology. Its basic teletypewriter compatability combined with its numerous "smart" terminal features satisfy the universal requirement for a low-cost, high performance video terminal.

You get everything you need. An upper and lower case character set displayed on a sharp 8 X 10 dot matrix. A full 24 line by 80 character screen. A status line displayed in reverse video. A complete ASCII keyboard with an 18-key numeric pad.

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segment.

This particular system has been in operation since July 1978. In the period covered by its operation, there have been no problems with any of the hardware or software components of the system. Normally, if component failure occurs, it comes in the first few hours of hardware operation—after the unit has been heated and cooled a number of times. Failures occur in equipment without regard for brand name or expense. These failures can usually be traced to the failure of an individual solid-state component in the system.

After the initial period of operation, periodic maintenance will be required on all moving parts: the printer mechanism, the disk drive mechanism and even the terminal keyboard, etc. Maintenance of the system must not be ignored if it is to be relied upon to perform on a regular basis.

Maintenance is not restricted to the hardware. For example, the software programs stored on diskettes and used frequently should be backed up by several copies in order to protect your system from the loss of data due to human error, such as the mishandling of the diskettes. This also applies to records such as the master file discussed in this article. After the completion of each change to these files, a copy should be made to ensure that the loss of the data on one diskette will not render your system useless.

The remaining item of maintenance is the replenishment of expendable supplies such as the printer ribbons and the various forms and paper used to run the system. The extent of attention to these items depends on the volume of business performed with the system.

At this juncture, we have fulfilled the promises given at the beginning of this lengthy article. If you have not received any new information from this reading, then we trust that you have found it interesting. If, however, you are among the majority of prospective business-computer purchasers, then we trust that our true objective was accomplished: to cast a beam of guiding light into the otherwise impenetrable darkness of computer acquisition and implementation.■

Appendix

Seals Electronics, Inc.
PO Box 11651
Knoxville TN 37919

Centronics Data Computer Corp.
1 Wall Street
Hudson NH 03051

Lear Siegler, Inc.
714 N. Brockhurst St.
Anaheim CA 92083

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- **200 NS for TRS-80*, Apple II, Sorcerer (specify) $99.00**

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LETTER QUALITY HIGH SPEED PRINTER

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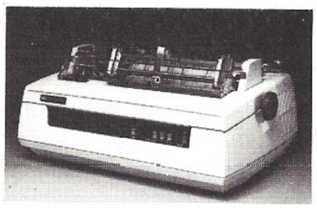

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Build a SISTER for Your 6800

Speed is a disadvantage while you're troubleshooting. Slow down with SISTER.

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Your latest program bombs out, and you are unable to locate the problem! What you need to do is put this SISTER to work on it. For a little time and a few bucks, you can gain an addition to your microcomputer that will move you a step closer to the big guys.

In large computers the usual methods of software debugging are to single-cycle, single-instruction or breakpoint-step a program through a problem area. The 6800 microprocessor has a software interrupt (SWI) instruction within its instruction set that is used for this purpose by most monitor firmware in read only memory (ROM). The most common monitor, MIKBUG, performs a status dump on encountering an SWI.

The information dumped is the Condition Code register (CC), B accumulator (B), A accumulator (A), index register (X), Program Counter (PC) and Stack Pointer (SP). With this information we know what the computer is doing. However, this is only an instruction-replacement technique and cannot be used in ROM, since you must replace a program instruction with the SWI (and then later remember to change it back to the right value).

Some test programs do a simulation of the instructions in a program to demonstrate that it does execute the instructions as expected. Usually a limited status dump (PC, op code and operand) is displayed for each instruction. This verifies that the program executes the instructions it should in the expected manner, but it does not execute the program itself. If you have a problem that these software techniques cannot solve, what do you do?

The answer is to build this hardware Single-Instruction STeppER (SISTER) circuit, which is one of the most useful devices for troubleshooting both software and hardware problems. This hardware approach also has several advantages. First, no restrictions are placed on the type of memory the program is in; it may be read-write or ROM and may be located anywhere in the address space.

Second, neither SWI instructions nor simulation techniques are used. Each instruction is executed at full speed, but only one at a time. No SWI's are ever left in the program because they were forgotten. The information displayed is the instruction address (in essence, the PC) and op code, which is enough to follow your program for debugging. Last, the circuit is easy to interface with the 6800 hardware due to the direct timing requirements of the 6800 microprocessor.

The 6800 has a hardware input called $\overline{\text{HALT}}$ that, when low, stops all program execution in the processor at the end of the instruction currently in execution. Does this mean that you can stop the operation of the processor and look at the external 6800 activity on the instruction just executed? Well almost! Once the processor halts, all three-state lines go into their high-impedance state, valid memory address (VMA) goes low and bus available (BA) goes high.

What all this means is that no valid information is on either the data bus or the address bus because they are in the high-impedance state and all memory and input/output (I/O) devices are locked out because VMA must be high to access them. To make use of the $\overline{\text{HALT}}$ line requires a circuit that will capture the address bus and data bus information at a point in the instruction execution when the instruction op code and its address are valid. A simple design to halt the 6800 is offered by Motorola in the *M6800 Microprocessor Applications Manual*, but more circuitry is required for the design to be useful.

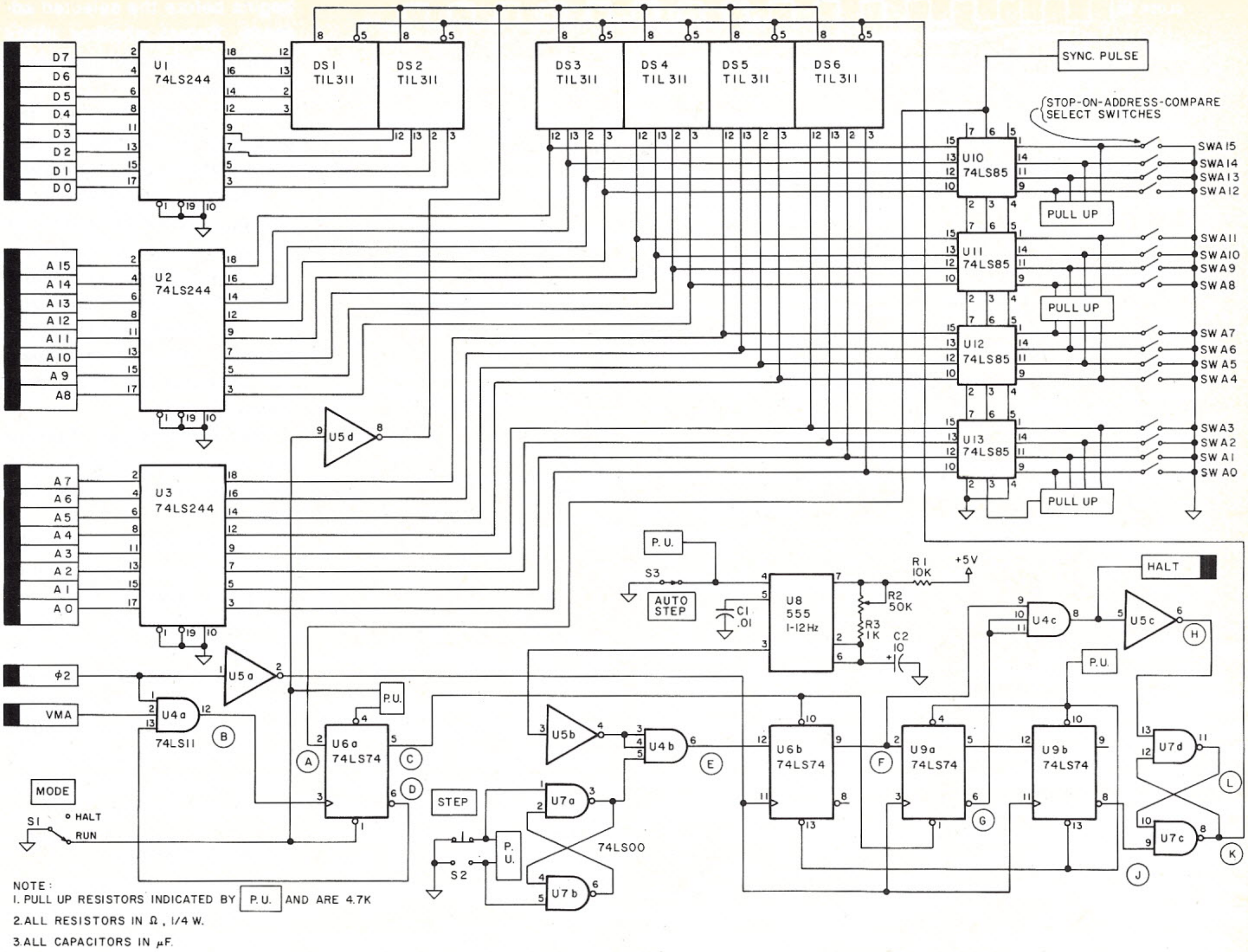
Motorola does give the timing requirements needed to design a circuit to capture the address bus and data bus information at the correct time. Fig. 4-1.2-1 on page 4-14 (whatever happened to simple number callouts?) shows that on the leading edge of the phase one (Ø1) clock following the instruction op code fetch, both address and op code information are valid for the instruction being executed.

Also, a couple of timing restrictions are placed on the use of the $\overline{\text{HALT}}$ line. The high-to-low transition *must* occur before the last 250 ns of the Ø1 clock, and the $\overline{\text{HALT}}$ line *must* go high for one clock cycle to ensure single-instruction-step operation. This is all the information needed to design a circuit to accomplish our goal.

The circuit described here has the capabilities to (1) stop on an address compare, (2) single-instruction-step, (3) auto-advance single instruction step and (4) display the address bus and data bus information in each of the first three modes.

Designator	Device	Vcc	Ground
U1, U2, U3	74LS244	20	10
U4	74LS10	14	7
U5	74LS04	14	7
U6, U9	74LS74	14	7
U7	74LS00	14	7
U8	555	8	1
U10, U11, U12, U13	74LS85	16	8
DS1, DS2, DS3			
DS4, DS5, DS6	TIL311	1 & 14	7
C1	0.01 uF		
C2	10 uF, 15 V		
C3 to C12	0.1 uF (one per two ICs)		
R1	10k, ¼W		
R2	50k (linear-taper potentiometer)		
R3	1k, ¼W		
R4 to R25	4.7k, ¼W (pull-ups to −5 V)		
S1	Switch, SPDT, Toggle		
S2	Switch, SPDT, push-button		
S3	Switch, SPST		
S4 to S19	Switch, SPST, binary		
Other	Misc. hardware and mounting board		

Parts list.



Circuit diagram.

In addition to all this, a synchronization pulse is generated on the address compare condition in the normal (RUN) mode. This sync pulse can be useful for timing measurements and in troubleshooting.

The circuit is composed of four basic sections: the bus buffers, the compare logic, the halt control logic and the display. Let's look at each section in detail so you will have a good understanding of how the whole circuit operates.

Bus Buffers

The bus buffers (U1-U2-U3) are 74LS244 octal drivers that have PNP inputs for low loading on the bus and to isolate the circuit from the microcomputer. The address buffers drive both the compare and display sections, while the data buffers drive only the display section. Both sets of the buffers are enabled all the time for write-only operation.

Compare Section

The compare section is made up of four 74LS85 4-bit comparators (U10-U11-U12-U13), the switches to set the stop-on-address-compare address and their pull-up resistors (to ensure an open is a high level). The comparators continually test the switch data with the address bus information, and on a compare condition, the final comparator output goes high for the one clock cycle containing the matching address.

As long as the mode switch (S1) is set to RUN, a compare condition has no effect on either the SISTER's match flip-flop (U6A) or the microcomputer because U6A is held in reset. Gate U4A ensures that the compare pulse is detected by U6A only on a VMA and Ø2 clock, and the first compare pulse (VMA·Ø2·U6A·$\overline{Q}$). When S1 is switched to the HALT position, U6A is no longer held reset, and on a compare condition, the high compare pulse is clocked through U6A, thereby enabling the halt control logic.

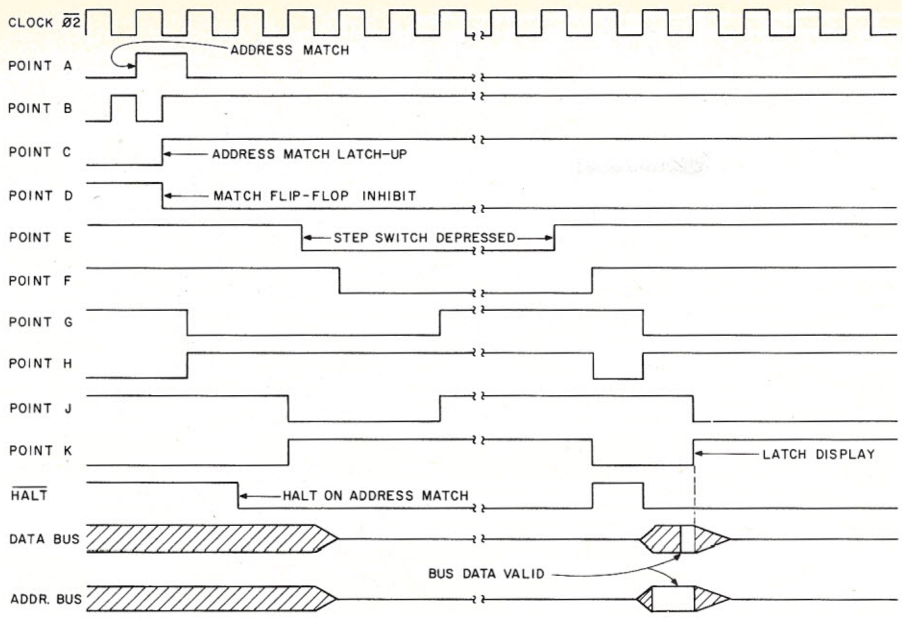
The microcomputer is halted at the end of the current instruction, and the display now indicates the address and op code of that instruction. At this point the microcomputer is waiting to either return to the RUN mode or to single-instruction-step.

Halt Control Logic

The halt control logic consists of U4B and C, U5B and C, U6B, U7, U8 and U9. Follow the logic and timing diagrams carefully while in this section. This is the part of the circuit that does all the work and must be well understood. U6B and U9A are held set and reset, respectively, by the output of U6A until S1 is put in the HALT position and an address match condition occurs. The microcomputer $\overline{HALT}$ line is also held high due to both points F and G being high.

When an address match does occur, the high pulse at point A is clocked through U6A and releases U6B and U9A from their controlled states. The high level at point E is clocked into U6B (no change from the set state it was in) and another clock cycle later into U9A. Point G going low causes the $\overline{HALT}$ line to the microcomputer to also go low. This halts the microprocessor.

On the next clock cycle the high level is clocked into U9B causing point J to go low. This forces point K high, which removes the enable from the display and latches the contents of the address and data buses into the readouts. The address match information is displayed, and the computer is



Timing waveforms for the 6800 SISTER.

now waiting.

When the Step switch (S2) is depressed, point E goes low and is clocked into U6B on the next rising edge of the clock, making point F go low. Point G goes high on the next clock rising edge, and point J goes high on the following clock rising edge. The $\overline{\text{HALT}}$ line to the computer is still low.

On the release of S2, point E returns high, and on the next rising edge of the clock, point F goes high. This causes the $\overline{\text{HALT}}$ line to go high and point K to go low to enable the display. On the next rising edge of the clock, point G goes low, forcing the $\overline{\text{HALT}}$ line low again. The $\overline{\text{HALT}}$ line was high for one clock cycle as required for single-instruction-stepping, and the processor executes the next instruction.

One more cycle of the clock takes point J low, causing point K to go high. This latches the address and op code of the instruction being executed at that time into the display. Upon completion of the one instruction, the computer returns to the halted mode, again waiting for you to single-instruction-step or return to the RUN mode.

The auto-step code is entered after the computer has been halted and is ready to single-instruction-step. Opening the Auto Step switch (S3) enables a 555 timer (U8) oscillator, which runs at an adjustable rate between 1 and 12 Hz (determined by setting the 50k Ohm pot in its timing leg). This has the same effect as repeated depressions of S2 and operates as just described in the preceeding paragraphs.

Display

The display section is made up of six TIL311 hexadecimal readouts (DS1 to DS6) that have internal logic to latch the hex data, decode it to the numbers 0-9 and letters A-F, and the light emitting diode (LED) drivers to turn on the 4 dot by 7 dot seven-segment LED characters. The displays are disabled by S1 until the halt mode is selected. If pin 8 on the TIL311 is high, the display will appear to be off.

Pin 5 is a strobe input that loads the data into the internal latches on a rising edge. The timing of the strobe signal from the halt control logic goes low to enable the display latches at the start of a single instruction step and is low for two clock cycles. It goes high at the proper time to capture the address and op code of the instruction in process.

The entire display sequence is as follows: in the RUN mode the display is off (as it is by S1 and U5D). Setting S1 to the halt mode turns on the readouts, which appear as a blur. When an address match occurs, a fixed value (hex, of course) is displayed.

Depressing S2 causes a new set of values in the display (the next instruction). Returning to the RUN mode turns off the display. If desired, the display may be enabled continuously by connecting pin 8 of each display to ground instead of U5D-8.

The TIL311 costs more than standard seven-segment displays, but the cost is offset by the savings in additional logic required to latch, decode and drive them, plus the added time to wire it all up. That, along with the confusion resulting from misreading the lowercase b and d, makes the hex display worth the cost. With the TIL311, there is never any question about which character is displayed.

Functional Operation of the SISTER

You have hit a program problem that needs a SISTER, and you have it connected in the manner required to obtain the proper bus signals. Set the Address Compare switches to an address in the program's problem area, set S1 to the halt position and then begin executing the program from its starting point. If the selected address is not reached (the computer is not stopped by the SISTER), and if the program has bombed, it indicates that the problem begins before the selected address. Select another likely point in the program and repeat the process.

When a match occurs, the processor is stopped, the address and data bus information is displayed and the unit is waiting to show you where the problem is. Repeating this process until you reach a point just before the problem area and then single-instruction-stepping the program allows you to locate the problem in logical steps.

The auto-advance feature may be used to step through loops or to watch program activity.

In the RUN mode the SISTER has no effect on the computer operation. However, the match line, U10-6, is always enabled. This results in a pulse-out each time the preselected address (set into the Address Compare switches) is on the computer bus. This signal may be used in troubleshooting or as an effective timing reference.

Special Comments

The 6800 microprocessor employs a look-ahead feature that you should be aware of. The PC is always incremented to the address of the next instruction in program memory during the execution of its current instruction in process. The sequence of events in the execution of an instruction is as follows: on the first cycle the op code is fetched, taken into the instruction register and decoded to determine the requirements (memory bytes and clock cycles). The required number of bytes is fetched from memory and the instruction is executed.

However, the processor has incremented the PC to the address of the next instruction in the program memory—looking ahead to the next instruction, even though the current instruction may be a branch or jump that will result in an address other than the next program instruction. The false address may even be put on the address bus, which would cause the SISTER to halt the processor when it really should

not.

This causes what looks like an error in the SISTER if the address selected is one following a branch- or jump-type instruction, which results in a different value in the program counter than the address of the next byte in the program memory. Care must be used in selecting the address for a stop-on-address compare condition with the SISTER.

The SISTER performs its functions by halting the operation of the 6800 and, therefore, finds more limited use in a real-time or interrupt-driven system. If the computer is halted, it cannot respond to a real-time input or interrupt. Even in such a system, SISTER is still helpful as a first-time event detector and as a sync pulse generator.

Construction Hints

Any wiring technique may be used in the construction of your SISTER; however, most of the logic elements should be located near the computer motherboard. This is especially true of the bus buffers.

Normally, the microprocessor has all its bus lines buffered before they go to the motherboard, which is the recommended place to pick them up. Certainly the display section and all switches can be located at a distance so that the logic may be connected to the computer bus all the time, and yet the controls may be at a convenient location. This could even be done with a connector on the computer to mate with a special display/control box, which would be put into use only as needed.

Several SISTERs have been constructed with long leads to a 40-pin DIP-clip used to clip onto the 6800. In each case this has worked well, but it is not the recommended method. The use of a DIP-clip with long leads could overload the drive of the 6800 and cause the computer to malfunction or quit.

Further Applications

A further application of SISTER could be to display and set memory (RAM) when in the halt mode. Data in any location could be displayed on the data readouts by using a halt mode replacement for VMA and adding three-state buffers to put the address select switches onto the computer bus. Data could be loaded and changed while in the halt mode by adding a set of data switches, three-state buffers to put them onto the computer data bus and a data-store push-button switch on the read/write line.

These additions would allow the display of any memory location and the setting of any RAM location data. These are nice things to be able to do. ■

64K Bytes on One Board!

Gone are the days when memory occupied most of the slots in your S-100 motherboard.

Ron Derynck
#28, 336 Rundlehill Dr., N.E.
Calgary, Alberta, Canada
T1Y 2Y2

Late in 1977 I had convinced myself that the time had come to add memory to my Z-80 computer system. This system is a home-brew unit using a variety of S-100-compatible cards from different manufacturers. I had decided to purchase two 8K static memory boards when I saw an S.D. Sales advertisement offering a 32K RAM board for $427. (This price has since been raised to $475.)

This kit looked like a good deal, and I was somewhat surprised that the magazine containing the ad arrived before I sent my money away for the other 8K memory kits. Normally when a magazine contains an ad for a better or less expensive product, the post office manages to delay delivery of the magazine until after I have placed an order for a similar but more expensive item!

The memory kit, which S.D. Sales calls the Expandoram, uses 8K × 1 bit dynamic memories and can be ordered with either 8K, 16K, 24K or 32K bytes of RAM. Currently each additional 8K costs $108. Even at the new price of $475 for 32K, the Expandoram is one of the least expensive memory kits on the market, costing only 1.45 cents per byte. Besides the low cost, the Expandoram offers a number of other significant benefits as follows.

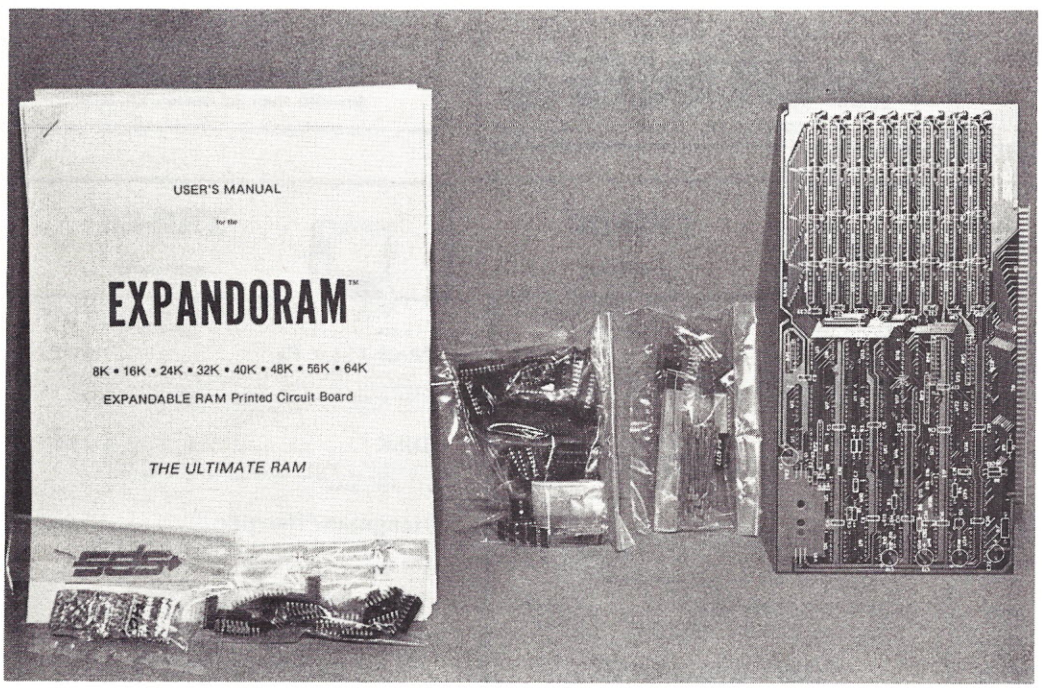
1. The memory is available in increments of 8K, allowing me to buy the 16K I need now and expand later at a lower cost than buying 8K static boards.

2. The memory uses one PC board and one bus slot for 32K of memory, thus minimizing construction time and making more slots available on the motherboard for other uses.

3. The board is designed to use the 16K × 1 memory chips in place of the 8K × 1 ICs, allowing board capacity to be doubled to 64K if required (the kit with 64K is priced at $995).

4. The 8K and 16K memory chips are still quite new and supply is tight. As more manufacturers start to turn out large quantities of 16K dynamic RAMs, the chip price should follow the IC industry's standard price curve and start to decline, making upgrading the kit even less expensive than it is currently. At the Second West Coast Computer Faire, I saw 16K chips being sold for $25, or $1.56 per 1K, very close to the cost of the common 2102 1K memory. In a year the price should be even lower.

The combination of the four advantages cited above and the low price prompted me to order an Expandoram with 16K bytes of memory. Delivery was quoted at six to eight weeks. Almost exactly eight weeks after I had sent in my order, I received a card from Canadian Customs indicating that they were holding my memory kit for ransom. After parting with more money to help support the bureaucracy, I was the proud owner of a new memory kit.



The Expandoram kit after being removed from its shipping box. All components, except the PC board, came in one of the four small plastic bags. The 8K memory ICs are in the bag on the left and are wrapped in foil. All photos by the author.

Expandoram Features

Just what had my hard-earned money purchased for me? Well, the PC board is of excellent quality, like all other S.D. Sales boards I have seen. The board has gold-plated edge connector fingers, a solder mask on both sides and plated-through holes. There are about 1100 solder joints to make, but with the solder mask it is virtually impossible to end up with a solder

bridge shorting traces together even in the memory array where traces run between the IC pins. The front of the board has the component designations for all parts silk-screened onto the board, thus simplifying construction and troubleshooting.

Although I ordered the 16K version, sockets were provided for the full 32K memory array as well as for all other ICs. The majority of the resistors required for the circuit are supplied in single in-line (SIP) or dual in-line (DIP) packages, thus making construction easier. Wire-wrap posts are provided for selecting the various board options. All the ICs had recent date codes, and the majority of the TTL-support chips were the low-power Schottky type (74LSXX series) to minimize power consumption.

A 30-page user's manual comes with the Expandoram kit. It describes the board in general terms, has a detailed schematic diagram, a parts layout diagram, a parts list, timing diagrams and a listing of a memory test program. The construction portion of the manual has a checklist to follow when you're building and testing the board. A utilization section discusses how to select the various Expandoram options. Although not a Heathkit-type manual, it will provide you with sufficient information to successfully complete construction of the board.

Fig. 1 shows a block diagram of the Expandoram in the format suggested by Mike Smith in issue No. 6 of *Kilobaud*[1]. You will note that Fig. 1 is more complex than the typical 4K memory block diagram shown in Mike's article. This is chiefly due to the refresh circuits (outlined by the dashed lines in Fig. 1) required to ensure that the dynamic RAMs do not lose their contents if not addressed often enough. I'll be talking more about the characteristics of the dynamic RAMs later in the article.

Fig. 1 makes all the main features of the Expandoram readily apparent. All inputs to the board are buffered by low-power Schottky ICs. The address bus and all control signals utilize 74LS14 hex inverters, with Schmitt trigger inputs for maximum noise immunity to prevent any "ringing" or other noise on the S-100 bus from adversely affecting the memory.

The data out lines (DO 0–DO 7) from the CPU are buffered by a 74LS244. This IC comes in the new 20-pin DIP package and is especially designed to be compatible with microprocessors since it contains eight buffers in one IC package. These buffers, like the 74LS14, have hysteresis on their inputs to increase noise immunity.

In addition, they feature PNP inputs that reduce the dc loading on the bus to almost half the load of conventional low-power Schottky circuits. The output of these buffers can sink up to 24 mA, the equivalent of driving 15 standard TTL loads.[2] Output from the memory is latched by a 74LS373 octal latch with three-state outputs. This device also comes in a 20-pin DIP package and has the same 24 mA output drive capability as the 74LS244.

The memory array is organized as four separate memory banks with either 8K or 16K bytes per bank, depending on whether the MK4115 or MK4116 RAM is used. Four write-protect DIP switches allow any or all banks to be write protected. A second set of DIP switches is used to select the address range for each bank.

If the MK4116 16K RAM chip is used, each bank can be individually enabled or disabled. In this case, if a bank is enabled, bank 0 is addressed as 0 to 16K, bank 1 as 16K to 32K, bank 2 as 32K to 48K and bank 3 as 48K to 64K. Table 1 lists the address range options for this case.

When the MK4115 8K RAM chip is used, each bank can be enabled for one of two separate address ranges or it can be disabled. Table 2 shows the addressing options for this case.

In addition to allowing each individual bank to be disabled, the board has provisions to allow the entire board to be

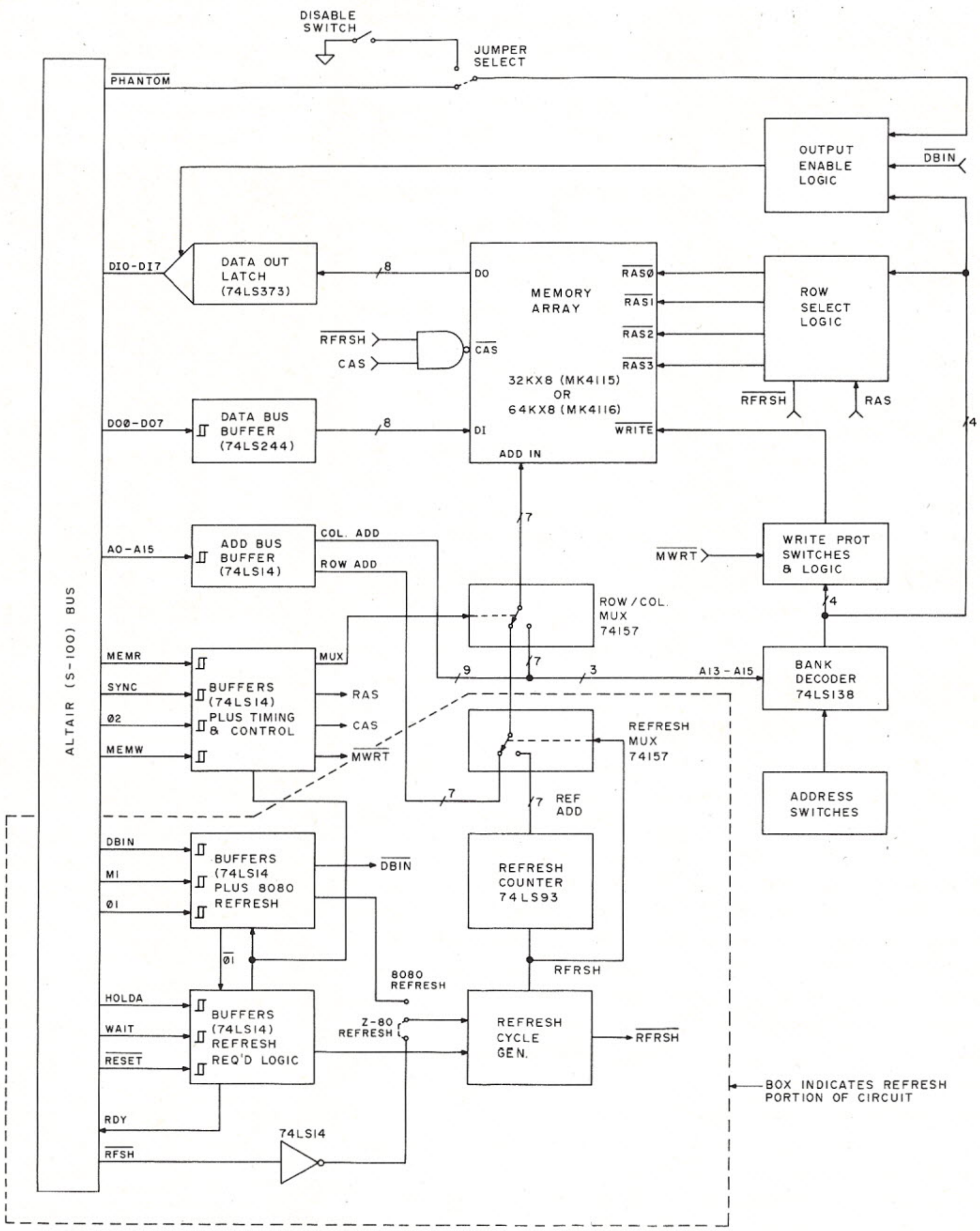


Fig. 1. Block diagram of S.D. Sales Expandoram memory kit.

SW1	BANK 0
OFF	DISABLED
ON	0-3FFF

SW2	BANK 1
OFF	DISABLED
ON	4000-7FFF

SW3	BANK 2
OFF	DISABLED
ON	8000-BFFF

SW4	BANK 3
OFF	DISABLED
ON	C000-FFFF

Table 1. Address selection options for Expandoram equipped with MK4116s (note: SW5-SW8 are not used).

SW1	SW5	BANK 0
OFF	OFF	DISABLED
ON	OFF	0000-1FFF
OFF	ON	8000-9FFF
ON	ON	NOT ALLOWED

SW2	SW6	BANK 1
OFF	OFF	DISABLED
ON	OFF	2000-3FFF
OFF	ON	A000-BFFF
ON	ON	NOT ALLOWED

SW3	SW7	BANK 2
OFF	OFF	DISABLED
ON	OFF	4000-5FFF
OFF	ON	C000-DFFF
ON	ON	NOT ALLOWED

SW4	SW8	BANK 3
OFF	OFF	DISABLED
ON	OFF	6000-7FFF
OFF	ON	E000-FFFF
ON	ON	NOT ALLOWED

Table 2. Address selection options for Expandoram equipped with MK4115s.

disabled. This can be done by using the fifth switch in the write-protect switch group or by the PHANTOM DISABLE in systems such as Processor Technology's SOL-20, which generates this signal. Selection of which method disables the board is made by installing wire-wrap jumpers.

Although the board disable feature may be useful in some systems, I feel it would have been better to allow the board to decode a set of address lines to select the memory board. This would require using more than 16 address lines since one Expandoram can hold a full 64K of memory.

I suppose the biggest drawback to this approach is that there is no standard way of implementing memory addressing beyond 64K on the S-100 bus. However, when one board can hold the maximum amount of memory that can be addressed with 16 bits, some thought should be given to provisions for allowing multiple memory boards to be used in the same computer.

The Expandoram PC board is designed to accept the MK4115 8K RAM without requiring modifications to the board. However, if the MK4116 16K RAM is used, it is necessary to break three etch lines and add three jumpers to the board.

In the manual I received with the Expandoram there are errors in the section of the schematic diagram dealing with the address decoding. Fig. 2a is the incorrect part of the schematic, while Fig. 2b is the corrected version obtained by tracing the etch lines on the board. The original schematic diagram has the jumper points E_4, E_5 and E_8, E_9 interchanged. Also, three of the address lines going to the 74157 multiplexers are mixed up. There is also a mistake on the silk screen on the front of the board. There are two jumper points labeled E_{10}. The one between U_5 and U_6 should be labeled as E_{18}.

Despite these errors in the schematic diagram, the procedure described in the manual for converting the board to use 16K RAMs is correct, provided that the point between U_5 and U_6, labeled E_{10}, is treated as E_{18}.

It should be noted that it is not possible to mix 8K and 16K RAM chips on the same board. Also, the 8K RAM chips are available in two versions, which cannot be intermixed. One version is the MK4115-40, while the other is the MK4115-41. It appears that these 8K RAMs are actually 16K RAMs, with only one-half the memory array completely functional. The good half is selected by tying A_0 either high (MK4115-41) or low (MK4115-40) during the column address strobe.

Dynamic RAMs

Before the remainder of the circuits on the Expandoram can be discussed, it is helpful to understand the characteristics of the dynamic RAMs used on the board. Several related articles[3, 4, 5] have described the use of 4K and 16K dynamic RAMs. I will try to summarize the important points in these articles, but the interested reader should review the papers referenced above for more detail.

Most hobbyists are probably aware that there are two different types of semiconductor random access memories available, namely static and dynamic RAMs. Fig. 3, taken from reference 4, shows the basic storage cell for both memory types. The static RAM uses a flip-flop to store a bit of data, while the dynamic RAM stores data as a charge on a capacitor. Static RAMs, such as the popular 2102 1K, are very easy to use. Nearly all 4K and 8K hobby memory boards utilize 2102 memory chips.

The problem with dynamic RAMs is that with time the charge leaks off the storage capacitor. Therefore, the charge must be replenished periodically, usually within 2 milliseconds. Replenishing the charge is called refreshing the RAM.

Dynamic RAMs are organized as a matrix with each bit selected by applying a unique row and column address. Anytime a location in the memory chip is addressed, all cells in that row are automatically refreshed. Thus, if each row is sequentially addressed, refreshing will occur automatically.

However, when used as a computer system memory, locations are accessed randomly and not sequentially by rows. For example, if a program is in a

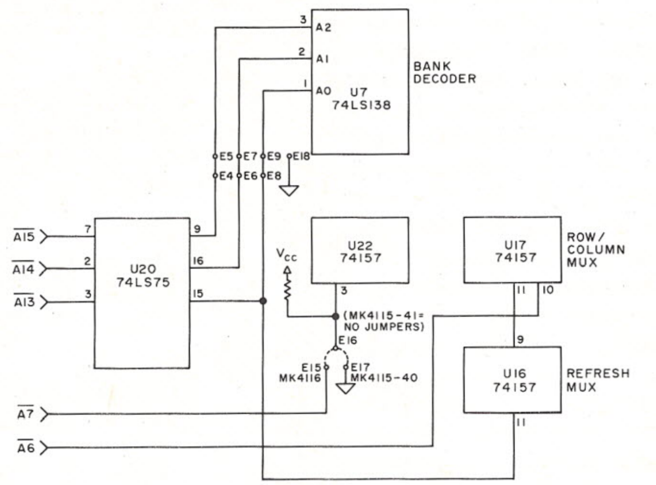


Fig. 2a. Simplified Expandoram address circuits as per documentation supplied.

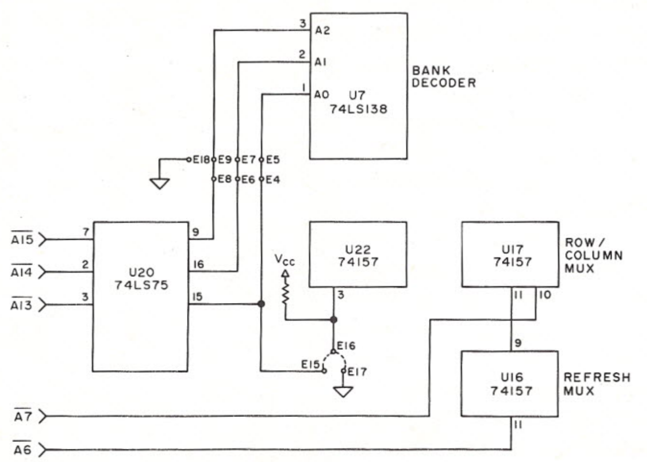


Fig. 2b. Actual address circuits of the Expandoram.

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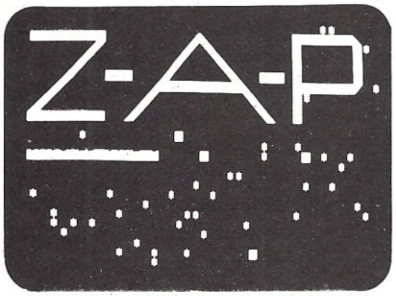

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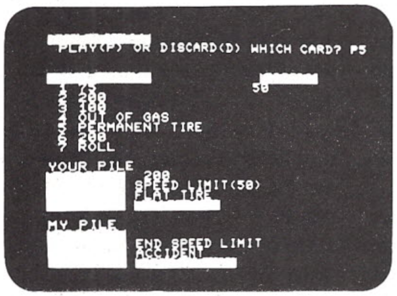

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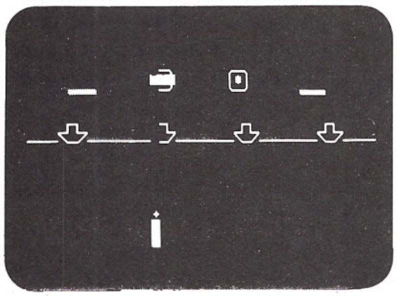

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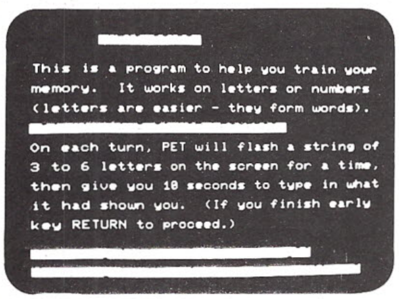

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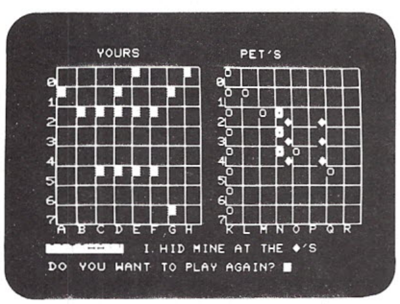

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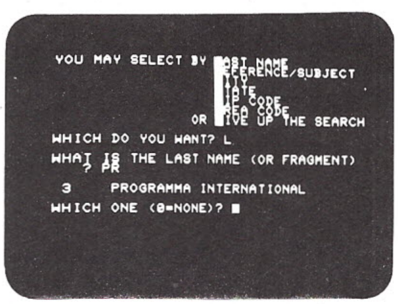

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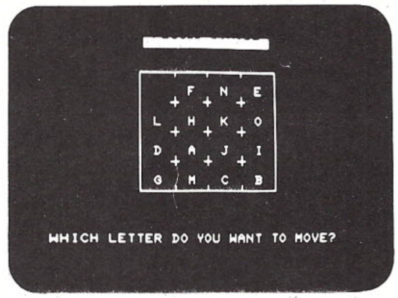

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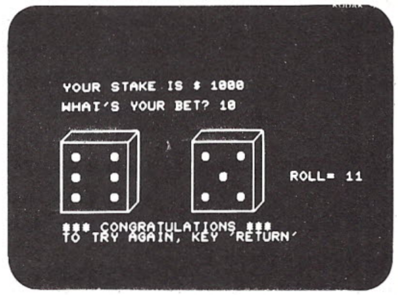

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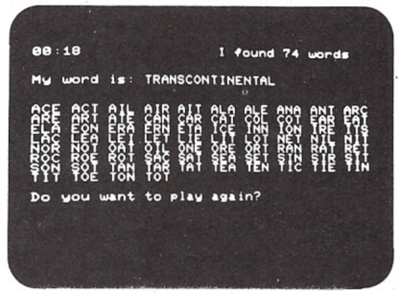

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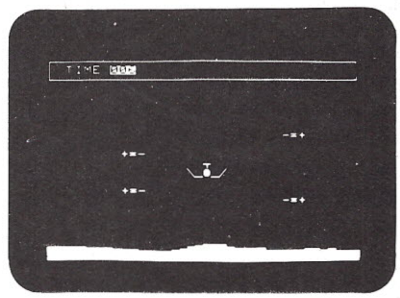

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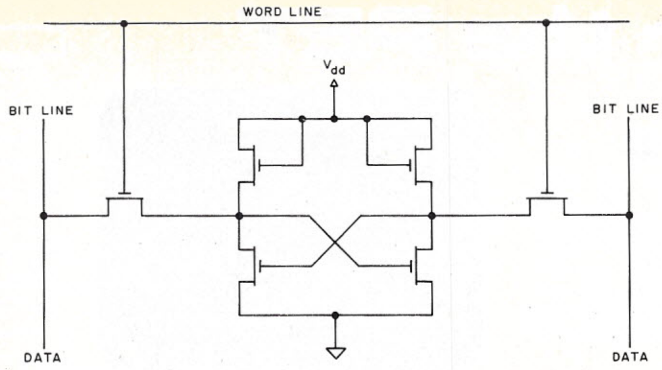

Fig. 3a. Static RAM flip-flop storage cell.

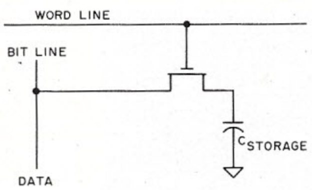

Fig. 3b. Dynamic RAM storage cell.

loop waiting for keyboard input, all instructions fetched from memory could be from a small area of RAM within one row. In order to prevent other rows from losing their data, it is therefore necessary to provide an external means of refreshing the memory.

One way to do this is to stop the CPU every 2 milliseconds and use a counter to run through all the row addresses to refresh the memory and then return control of the CPU.

As stated previously, accessing a bit in each row every 2 milliseconds will refresh the entire memory. There is a second way to refresh dynamic RAMs, called transparent refresh. This method does not stop CPU processing to refresh all rows at once. Instead it refreshes each row, one at a time, while the microprocessor is busy with internal processing and thus not accessing the memory.

After each instruction fetch cycle, the CPU must spend some time decoding the current instruction and deciding what to do next. It is during this time that transparent refreshing can be done.

The Z-80 microprocessor is specially designed to use dynamic RAMs. It provides an output called $\overline{\text{RFSH}}$ after each fetch cycle, indicating that the dynamic memories should perform a refresh cycle. In addition, it outputs a 7-bit refresh address while $\overline{\text{RFSH}}$ is active. This address is incremented by the Z-80 before the next refresh cycle, thus greatly simplifying use of dynamic RAMs with the Z-80.

Multiplexed Dynamic RAMs

When the 4K dynamic RAMs were first introduced a few years ago, they came in 18- or 22-pin DIPs. Later, Mostek introduced a 16-pin 4K RAM that had the advantage of using less board space than the larger packages. In order to fit the part in a 16-pin package, it was necessary to multiplex the row and column addresses over one set of address pins.

This is done by using an external set of multiplexers and three timing signals. The first timing signal is called the row address strobe, or RAS, and is used to latch the row address on the chip. Next, a signal called MUX is used to switch the multiplexer to select the column half of the address. While MUX is active, the column address strobe, or CAS, latches the column address into the memory.

The MK4115/16 chips used on the Expandoram are also 16-pin RAMs but with a capacity of 8K or 16K bits, respectively. Fig. 4 illustrates the differences between the two types of dynamic RAM chips.

Dynamic RAM Advantages

If you get a chance to read references 3, 4 and 5, you will note that dynamic RAM memory systems must be carefully designed with particular attention paid to power supply decoupling, timing and other factors. It was comforting to read these articles and then find that the Expandoram design conformed with nearly all the guidelines suggested by the authors.

About now you are probably wondering why dynamic RAMs should be used at all considering the need to refresh them, multiplex them and take special care when designing memory boards around them. Yet nearly all the major minicomputer makers are starting to use 4K or 16K dynamic RAMs in their systems. In the hobby computer field the Apple II and the Radio Shack TRS-80 use dynamic RAMs. Obviously, there must be some advantages to using dynamic RAMs to compensate for their added complexity.

One advantage is lower power consumption and, therefore, less expensive power supplies. When dynamic RAMs are cycled continuously, they draw about as much power as static RAMs. However, between cycles they draw very little power.

The Expandoram minimizes power consumption by activating only one bank at a time instead of the whole memory array. Therefore, only one-quarter of the RAMs on the board are cycling while three-quarters are idle.

As shown in Fig. 3, the dynamic RAM cell is much simpler than the static RAM cell. This means that the dynamic RAM chip will always be smaller and therefore less expensive than the equivalent static chip.

If you look at the ads in the back of this magazine, you will note that 4K dynamic memories are at least half the price of 4K statics. Since the dynamic memory cell is small, more bits can be placed on a chip and the chip can be manufactured with reasonable yields. The current state of the art is 16K dynamic RAM memories compared to 4K static RAMs. These two factors, low price and high memory density, are what made the Expandoram so attractive to me, and both of these features are made possible by the use of dynamic

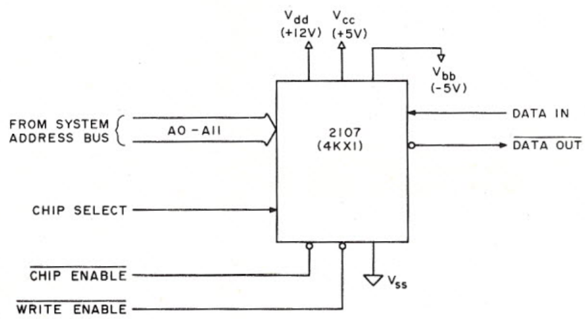

Fig. 4a. Intel 2107 4K × 1 dynamic RAM in a 22-pin IC package. Note that the 12 address lines required to address 4K are directly connected to the IC.

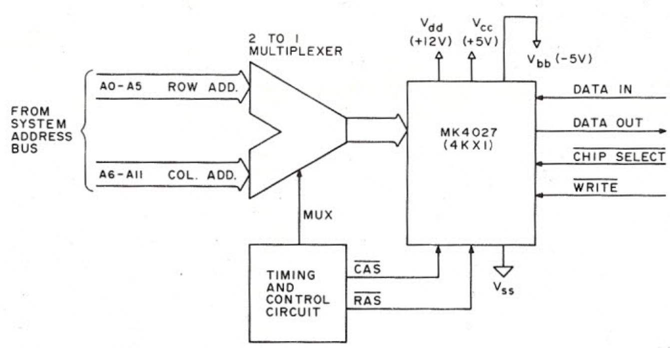

Fig. 4b. MK4027 4K × 1 dynamic RAM in a 16-pin IC package. Note that an external multiplexer is required to reduce the number of address lines from 12 to 6. The MK4115/16 8K/16K RAMs come in the same package but with the $\overline{\text{CHIP SELECT}}$ input replaced by a 7th address input. Chip selection is accomplished by applying both $\overline{\text{CAS}}$ and $\overline{\text{RAS}}$ to the desired IC.

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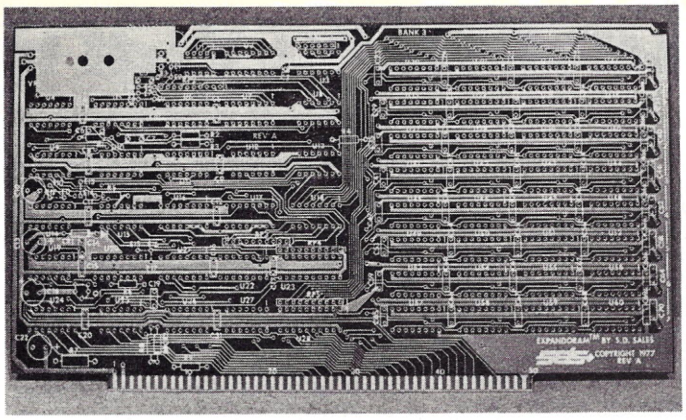
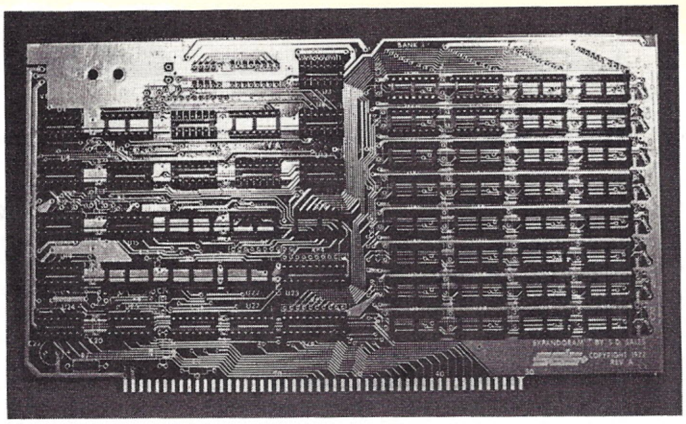


Close-up of the Expandoram PC board. As can be seen in the photo, all components are identified on the front of the board by silk-screened printing. The board also has a solder mask on both sides of the board and gold-plated edge connector fingers.



The first (and most time-consuming) task in assembling the board is soldering in all the IC sockets.

memories.

The use of the multiplexed 16-pin dynamic memories can also provide another benefit, as seen in the Apple II or TRS-80. Since both 4K and 16K memories fit in a 16-pin socket and have virtually identical pin-outs, it is easy to design a memory board that will accept either type by changing one jumper. Therefore, systems can be shipped with 4K of memory but easily upgraded to 16K.

Now that we have some basic information about dynamic RAMs, let's return to the discussion of the Expandoram board itself.

Refresh Circuits

Like all dynamic RAMs, the chips in the Expandoram memory must be refreshed at periodic intervals in order to retain the stored data. The Expandoram implements the RAM refreshing in a manner that is transparent to program execution. For Z-80 systems, this is easily done because the Z-80 provides a signal called $\overline{\text{RFSH}}$, which is active during the part of the instruction fetch cycle when the CPU is busy with internal processing. Thus, a refresh cycle is performed after each instruction fetch cycle, and it does not interfere with or slow down program execution in any manner.

It should be noted that the Expandoram always uses its own on-board counters for generating the refresh address, even when operating in Z-80 mode. Thus, the Z-80's $\overline{\text{RFSH}}$ signal is used to identify when a refresh cycle should be performed, but the refresh address output by the Z-80 is ignored.

For computers with 8080-based CPUs, a transparent refresh is obtained by decoding three of the 8080 control signals to detect when data has been read into the CPU during an instruction fetch cycle. The Expandoram then performs a refresh cycle immediately after the instruction has been transferred to the 8080. Wire-wrap jumpers are provided to select which refresh method will be used.

The refresh method described above only works while the CPU is executing instructions. There are situations where instructions may not be executed for long periods of time; thus the RAMs could lose their data. To prevent this from happening, the Expandoram detects these occasions and performs automatic refresh cycles. The Expandoram performs a refresh every 16 $\Phi 1$ clock pulses under the following conditions: (a) when the computer is reset for longer than 16 clock cycles; (b) when the computer is in the WAIT state for 16 clock cycles or longer.

Another potential problem occurs during DMA cycles which, since they are not instruction fetches, do not allow for transparent refresh to occur. A jumper on the Expandoram allows one of two options to be selected. The first option is to allow DMA to the Expandoram. In this case, DMA *must* be limited to a 1 millisecond maximum time period to prevent loss of data.

The second option is to disable the Expandoram during DMA cycles. This ensures that automatic refresh will occur every 16 clock pulses and no data will be lost. However, since the Expandoram is disabled, the DMA must occur between some other (static) memory and the I/O device, but not with the Expandoram.

Construction Hints

It took me about 4 hours, spaced over a couple of evenings, to complete construction of the board. Assembling the board is simple, and, as can be seen from the photographs, there are four steps required to complete the board: (1) soldering in the sockets; (2) soldering in the other components; (3) checking the power supply voltages; (4) inserting the ICs in their sockets.

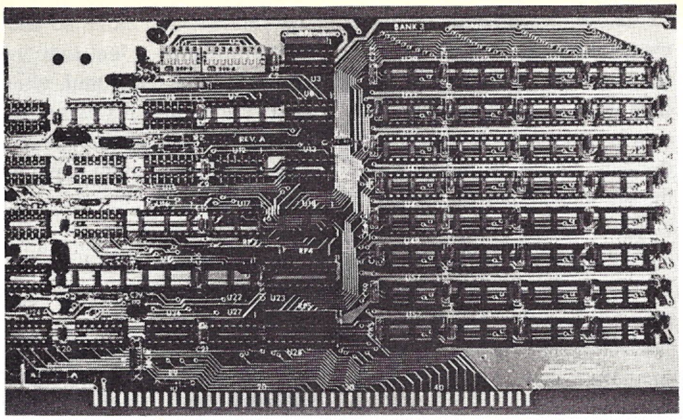
During construction I encountered a few minor problems:

- Resistor packs RP1 and RP2 are listed as being 3k or 3.3k, but the markings on the resistor package were a string of letters and numbers followed by 332. These last numbers are similar to the color bands on a resistor and mean 33 followed by two "zeros" or 3300 Ohms (3.3k).
- CR1 is listed in the assembly instructions as a 1N71; this is a typo and should read 1N751.
- The polarity sign for C19 is missing from the board. C19 should be installed with the red dot (positive lead) closest to the edge connector.
- The lead spacing on the 0.1 microfarad capacitors is too narrow for the hole spacing, and their leads must be formed to fit the board. This would not be worth mentioning except that there are 60 of these capacitors.
- The assembly instructions do not state which side of the board to install the wire-wrap pins from. I installed mine so that the wrap pin stuck out the component side of the board. I did this because the silk-screen labeling for these pins is on the component side and so the wrap pins would not interfere with a card installed in the slot behind the Expandoram.
- When installing the ICs in their sockets, it is necessary to first bend all IC pins slightly towards the IC package so the pins line up with the socket holes.
- It is not clear from the instructions how the delay line should be oriented in its socket. The pin labeled IN corresponds to pin 1.
- The instructions do not mention installing the 33 Ohm DIP resistor pack in the U18 socket. Be sure to do this.

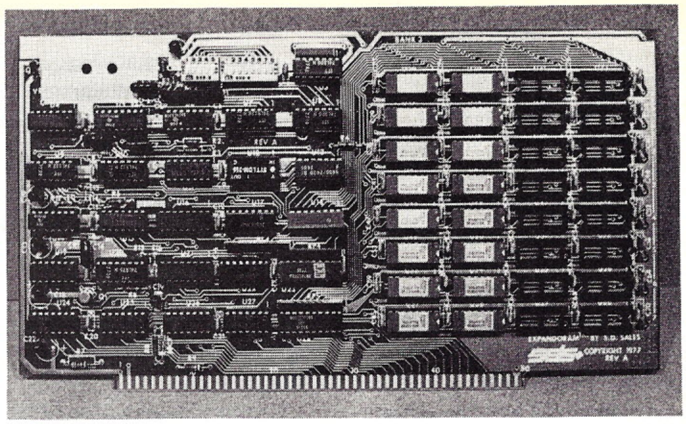
Checking It Out

The Expandoram manual contains a listing for a memory test program; however, I tested the memory with a program from a recent issue of *Dr. Dobb's Journal.*[6] The first time I ran the program, every fourth location contained an error!

After a while, when my heart started to beat again and I could



The next step is to add on the DIP switches, resistor packs, capacitors and other discrete components.



After checking the power supply voltages for all ICs, the integrated circuits can be inserted into their sockets to complete construction of the board. Note that I have not installed the two voltage regulators on the board because I use an external regulated +5 V, +12 V and −12 V power supply to power my computer system (instead of the usual onboard regulators).

think clearly, I was reasonably sure I had an addressing problem. Therefore, I wrote a small program loop to continually access one of the bad locations. Using my scope I traced the suspect address line through the board's logic circuits until it disappeared at one point. I pulled out the IC and found it had a bent pin and was not making contact with the socket.

After fixing the problem I reran the memory test, which worked perfectly. I was now the proud owner of 16K of fully functional memory, or so I thought.

When I tried to run a program in the Expandoram address space (instead of just reading from or writing to it as is done by the memory test routine), I found that the program would not run in the Expandoram. Yet this same program worked in an older memory board that I had.

I finally determined that the problem was not with the Expandoram but with my S.D. Sales Z-80 card. This Z-80 card does not always generate the PSYNC signal at the proper time. I found that the PSYNC signal was not generated correctly during a DJNZ (Decrement B and Jump on Nonzero) instruction.

Although the problem was on the Z-80 board, I decided to correct it by modifying the Expandoram memory read circuit as suggested on page 15 of the Expandoram manual. This modification makes the Expandoram similar to other memory boards where only an MEMR signal is required to trigger the memory read sequence. I have been using the Expandoram for three months and have had no problems with it at all since I made this revision.

Compatibility

Since I was using both the S.D. Sales Z-80 board and the S.D. Sales Expandoram, I was fairly disappointed that they would not operate together without modification. In fairness to the Expandoram manual, it did indicate what modification was necessary to make the memory work with some Z-80 cards. However, the manual did not state that the mod was necessary for the S.D. Sales Z-80. I would have expected that since both cards were from the same company they would have tested them together and stated specifically what changes were required to make them compatible.

Also, the modification note was worded to imply that some Z-80 cards *"do not generate PSYNC during an MEMR cycle."* In my case the S.D. Sales Z-80 does generate PSYNC, but for some instructions (such as DJNZ) it generates it at the wrong time. Therefore, because the manual was not clear in this area, I spent a lot of time figuring out what was happening and concluded that the modification suggested by the manual would indeed solve my problem.

That I experienced these problems supports the statement made by Don Tarbell in his letter on System Integration in the May 1978 *Kilobaud* (p. 17). Don stated that problems can arise "because some Z-80 boards don't create a true Altair bus environment." What is really sad is that the Altair bus is needlessly complex, especially for the newer processors such as the Z-80. However, I guess this is one price we have to pay for what "standards" we do have.

There are some other areas where the Expandoram may or may not be compatible with your system. For example, it uses two of the "undefined" Altair bus pins identified by Bill Fuller in his article in the July 1978 *Kilobaud.*[7] Pin 66 is expected to be the RFSH signal in Z-80 systems. This is the pin used for refresh by most Z-80 systems, except for the Ithaca Intersystems and Base 2 Z-80s, which use pin 67 as an RFSH signal.

The second undefined pin (pin 67) is optionally used by the Expandoram as PHANTOM DISABLE. This not only conflicts with the Ithaca and Base 2 RFSH signals, but also with S.D. Sales' own Z-80 board, which uses pin 67 as the nonmaskable interrupt. In fact, pin 67 has more definitions than any other single pin on the Altair bus, although PHANTOM DISABLE is the most common. If you are thinking of adding a board to your system, you should look at Bill's article first to see what problems you may encounter.

The Expandoram is specified to have an access time of 375 nanoseconds and a cycle time of 500 nanoseconds. The board has no provisions for generating WAIT states. Therefore, the Expandoram can be used with all 8080 systems, but only with those Z-80 systems running with a 2 MHz clock.

The Expandoram is really easy on your power supply. The current drains shown in Table 3 were measured with 16K bytes (16 MK4115s) of memory installed. If more memory is added, then the load on the 8 volt supply will not increase much. However, the load on the plus and minus 16 volt supply should increase proportionately to the amount of memory added.

Since I have no DMA devices on my system, I was unable to check out the Expandoram's operation under DMA. Reference 4 points out a potential problem with DMA and dynamic memories on the S-100 bus. The problem arises because the S-100 bus control signals are high true.

During the switchover from the CPU to the DMA device, the control bus is floating for a short period of time. Since TTL circuits treat a floating input as a "high" or logic one and since the control signals are high true, it is possible that a memory cycle could be triggered during the transfer of control from or to the DMA device. Dynamic memories must be allowed to run through a complete read or write

cycle once triggered.[4] Aborting a cycle or starting a second cycle too soon after the first could cause loss of data.

Judging from the Expandoram's circuit diagram, it appears that steps have been taken to prevent problems during switchover from, or to, DMA devices. I believe that as long as you operate under the restrictions described in the refresh section of the manual, the Expandoram will work in systems utilizing DMA devices.

Conclusions

Although I have discussed two problems I experienced with the Expandoram, I want to emphasize that neither problem can be blamed on this memory board. The first problem—the bent IC pin—was caused by my haste to complete construction of the board. The second problem—the incompatibility with my Z-80 card—was caused by that card's failure to exactly simulate the Altair bus timing under *all* operating conditions. Clearly the problem is not in the

Voltage	Current Required
+8V	325 Milliamps
+16V	50 Milliamps
−16V	15 Milliamps

Table 3. Power requirements of Expandoram using 16 MK4115 memory chips.

Expandoram, even though I fixed it by modifying the Expandoram slightly.

Obviously, if you have an 8080 CPU card, you will not experience the timing problem I had with my Z-80. In this case, I am fairly certain you will have no problems using the Expandoram. If you have a Z-80, you may or may not have to make the modification described on page 15 of the manual. It all depends on how accurately your Z-80 CPU card duplicates the 8080 timing signals. In fact, since I found the timing problem while a Z-80 instruction (DJNZ) was being executed, it might not even show up if you are running pure 8080 code on your Z-80.

As far as I am concerned, the Expandoram provides the most memory on the market for the least money. Furthermore, the card design conforms to the engineering guidelines for dynamic RAM boards published in the "professional" magazines.

So if you are looking for a low-cost, high-density, good-quality memory board, I suggest that you seriously consider the Expandoram. In this article I have tried to provide you with all the information you will need to evaluate the Expandoram and determine if it will work with your system.

In my system I expect that the Expandoram will be the primary memory board for many years to come. When the cost of 16K RAM chips drops low enough, I expect to upgrade from the 8K to the 16K chips. Eventually I expect to have 48K of memory on this board. The other 16K of address space will be used for ROMs, VDMs and a static RAM board.

Although I had a few problems getting the Expandoram operational, I am satisfied with its performance. I feel that the advantages of the board, cited at the beginning of this article, make it the best choice for providing a large memory capacity in my system. ■

1. M. C. Smith, "Build Your Own Interface," *Kilobaud*, June 1977, pp. 22-28.
2. Advanced Micro Devices, Inc., *Schottky and Low-Power Schottky Data Book*, Second Edition, 1977.
3. J. Winfield, "Dynamic Memories Offer Advantages," *Electronic Design*, July 5, 1977, pp. 66-70.
4. S. Calebotta, "System Design with Dynamic Memories Takes Attention to Detail," *Electronics*, February 2, 1978, pp. 109-113.
5. R. Blacksher, "Interfacing Dynamic RAMs to the Z-80," *Electronic Engineering Times*, May 15, 1978.
6. J. MacDougall, "Z-80 RAM Tester," *Dr. Dobb's Journal*, Vol. 3, Issue 2, p. 43.
7. Bill Fuller, "Compatibility and the Altair Bus," *Kilobaud*, July 1978, pp. 100-105.

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Peak Your TRS-80 Display

An easy modification increases the sharpness of your TRS-80 video display.

If you are interested in getting just a bit more sharpness on your TRS-80 video display, then you might consider this easily accomplished modification.

After removing the video display back cover, locate the green wire running from the terminal post at the front of the horizontally mounted circuit board to pin 2 of the CRT. There is also a 1500 Ohm resistor in series with this wire connected directly at the CRT socket pin 2 (wiring side, counting from the blank space clockwise for you youngsters).

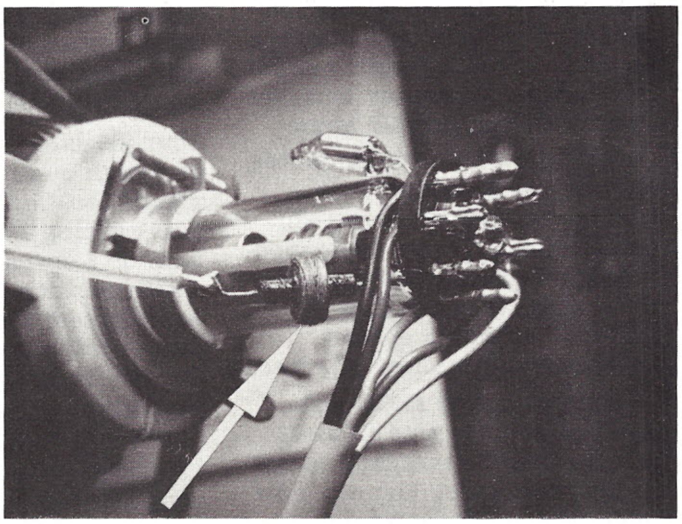
This green wire is the video signal feed to the CRT, and the first step toward increased sharpness is to make sure that this wire is as much in the open air as possible. If it is brought too close to any other component, it will cause a loss of high-frequency response and make the characters on the video display less sharp.

After checking the dress of the green wire as above, you can try increasing the sharpness of the display by adding some series peaking in this lead if you wish. You cannot get *more* high frequencies than are already present, but you can accentuate them with respect to the rest of the video signal with a peaking coil placed in the green lead.

Take it easy, though; as with most good things, video peaking can be easily overdone. Too much peaking can result in serious phase distortion that looks like smearing. You may have to experiment a bit with actual value of the peaking coil, but I ended up with about 100 uH in mine. Completely eliminating the 1500 Ohm series resistor will also help the high-frequency response somewhat.

That's all there is to it (I told you it was easy)! Even if you'd rather not experiment with the peaking coil idea, just knowing about the lead dress on that video wire could save you some grief if you ever have to get into the video display for other reasons!

Keeping the contrast on the display at about halfway (or less) on the control will also help sharpness; going much above this on mine starts causing white-level saturation, which results in loss of definition. The brightness should then be adjusted for a black (or dark gray) background.



The 100 uH peaking coil connected in place of the 1.5k resistor at pin 2 of the CRT. The green wire may be some other color on different productions runs, but it will always be connected to pin 2.

With the contrast set, you shouldn't have to adjust it anymore; just "ride" the brightness control if the screen darkens too much with a "mostly white" graphics display. The reason for that, by the way, is due to the absence of dc restoration in the signal path (hummm, that might be another interesting project to work on).

One final note of caution: Don't work on the video display with its ac line cord plugged into an outlet. This is a "hot chassis" set (no power transformer) and can put you across the ac line inadvertently! Keep it unplugged any time you may come in contact with the innards, and you'll be safe. ■

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Tiny Text Editor for the 1802

Unhappy with the lack of high-level software for the 1802, this author wrote his own.

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Canoga Park CA 91304

Almost from the moment I connected a TVT to my 1802 system, I began to bemoan the lack of high-level software for the 1802. Other than Tiny BASIC I was limited to a handful of machine-language programs. However, maybe this wasn't such a bad thing after all. Half the fun of having a computer is writing software. So after playing around a while with Tiny BASIC, I decided to spend some time writing that missing software. This article describes a Tiny text editor that resulted from that effort.

Why a text editor? Well, basically because it is a useful piece of software. You can use it to write and correct letters (you need a printer for this). But more important, you can use a text editor with other programs, such as assemblers and similar software that operates on previously prepared text.

A few words on the history of this program. I first wrote it as part of a Tiny PILOT interpreter. Consequently, I designed the command structure to be as simple as possible so that my kids could use it. I never really considered it as a general-purpose editor until the kids asked me to fix it so they could write letters. After stripping off the PILOT code and making some minor changes to the command set, I discovered that the editor was so easy to use that I hardly missed the features of more versatile full-scale editors.

One other note before I describe the editor. I have four friends with 1802 systems. Every system is completely different! I believe that this sort of diversity is the general rule with 1802 systems. The editor, of course, was designed around my system, which uses the UT4 monitor. However, the editor should be usable on other systems as well. Any system that can run Tiny BASIC should connect to the editor quite easily. Other systems may require some work. What any system does need is at least 2K of memory (1K for the code and buffers, the rest for text) and a means to display the ASCII text (a TVT or equivalent).

Name	Symbol	Format
UP	U	dd U or U dd
DOWN	D	dd D or D dd
BEGIN	B	B
END	E	E
INSERT	I	I text
KILL	K	dd K or K dd
WRITE	W	dd W or W dd
CLEAR	C	C
PLACE	P	dd P or P dd
SAVE	S	S
LOAD	L	L
MONITOR	M	M
TYPE	T	T

Definitions: dd—decimal number 0 to 99
text—any ASCII text string

Table 1. Editor commands.

Using the Editor

The editor functions by storing ASCII character codes in a section of memory called the text buffer. The text buffer is variable length and expands or shrinks as material is added or deleted. To conserve memory, lines of text are stored according to their actual size, and the carriage-return/line-feed pairs serve as line separators.

The editor was designed to work without line numbers. Thus it is useful for writing general text material such as letters and programs for non-line-oriented programming languages such as PILOT.

Of course, if line numbers are not used, then some other means for locating specific material within the text must be provided. The editor keeps track of where it is working by maintaining a text pointer (Register RA) that always points to the *start* of the current line. For the most part, the user is burdened with the task of mentally keeping track of the text pointer. However, to make this task easier, the editor generally prints out the current line after execution of a command.

To manipulate the text material the editor recognizes the commands listed in Table 1. When the editor is ready to accept a command, it issues a prompt (right arrow or greater than sign (>)). The user types in the command in the proper format and presses CR to cause execution.

To make operation of the editor as easy as possible, a loose format is allowed. Spaces are ignored and numbers may be entered on either side of the command. In addition, errors can be corrected by using back space or cancel (Control X). Back space deletes the previous character from the input line buffer and echoes characters to the TVT to cause erasure of the character on the screen. Cancel deletes the entire line from the line buffer and causes erasure of the line on the TVT.

If the editor detects an error (such as an invalid command), it will type out a question mark followed by a prompt.

The commands UP, DOWN, BEGIN and END serve to move the text pointer. BEGIN and END move the text pointer to the start and end of the text buffer. DOWN and UP move the text pointer a specified number of lines (1 to 99) relative to the current position of the text pointer.

The INSERT command is used to add one line of text to the buffer. Each line of text to be inserted must start with the letter I. The text pointer moves as text is inserted, allowing sequential entry of lines. For example, the commands:

```
I FIRST LINE
I SECOND LINE
I LAST LINE
```

will insert three lines of text in the proper order. The command opposite of insert is KILL. This command deletes the specified

number of lines from the text pointer.

As mentioned before, certain commands (UP, DOWN, BEGIN, KILL) type out the current line (the line immediately following the text pointer) after execution. When the INSERT command is used, material is added in front of (above, prior to) the current line. When the KILL command is used, the current line (and following lines when appropriate) is deleted. For example, the commands:

I FIRST LINE
I SECOND LINE
I LAST LINE
3 U
FIRST LINE*
2 K
LAST LINE*
I NEXT TO LAST LINE
*typed by editor

will leave the lines:

NEXT TO LAST LINE
LAST LINE

in the text buffer.

The WRITE command allows the user to review text material by typing out the specified number of lines (starting with the current line). This command is also useful when the user is uncertain of the location of the text pointer. This command does not move the text pointer or in any way alter the text material.

The CLEAR command serves to initialize the text buffer. When the editor is *first* invoked, this command *must* be used prior to all other commands. The exception to this rule is when the editor is to be used on text already existing in memory. This text must, of course, be in proper format for the editor as follows.

1. The text must be ASCII.
2. The text must start on a 1K boundary (0400H, 0800H, etc.).
3. The first character must be STX (02H).
4. The last character must be EXT (03H).
5. Text lines must be separated by CR/LF pairs.

If the CLEAR command is used during an editing session, it has the effect of erasing all text.

The PLACE command allows the user to specify (in 1K increments) the starting location of the text buffer. If the command is not used, the text buffer starts at 0400H. The main purpose of this command is to allow placement of the text at locations suitable for operations by other programs. Incidentally, this command can also be used to create multiple text files within memory.

The SAVE command dumps the entire contents of the text buffer to the cassette recorder (or other storage device). Similarly, the LOAD command fills the text buffer from the cassette. If text already exists within the buffer, the LOAD command will append the new text to the end of the existing text. This feature can be used to combine multiple text segments.

The TYPE command sends the entire contents of the text buffer to the printer. Nulls are inserted after each CR/LF to allow the print mechanism time to settle.

The final command is MONITOR, which initiates a return to the system monitor.

Implementing the Editor

In systems using the UT4 monitor, the editor is called with the command:

$PO

Other monitors will use different commands to call the editor. In general, the editor is called by loading a register (any register is permissible) with 0000 and making that register the program counter.

If monitors other than UT4 are used, it will be necessary to patch the I/O routines to the editor. Table 2 lists the codes that will require change. Replace the existing code with the absolute address of the appropriate I/O routine. The I/O routines must follow the conventions listed below:

1. The editor will echo characters input from the terminal back to the terminal. Therefore, the terminal and terminal input routine must not perform this function.
2. The I/O character is passed in RF.1.
3. I/O routines must return to

Address	Present Code	Function
0084	813E	Address of routine to input one character from the terminal.
0088	81A4	Address of routine to output one character to the terminal.
0274	8140	Address of routine to input one character from the cassette.
025F	81A4	Address of routine to output one character to the cassette.
00DA	13	ASCII character code to move cursor left one space.
00DB	15	ASCII character code to erase to end of line.
00E3	15	
02E4	81A4	Address of routine to output one character to the printer.
0117	8000	Entry address of the system monitor.
00B3	3E	Hex number to establish length (number of characters) of input line.

Table 2. Parameter addresses.

```
*?M0 2E7
0000 F800 B3F8 07A3 D3F8 00B4 F867 A4F8 00B5;
0010 F877 A5F8 03B2 F8FF A2D4 005C 00F8 0457;
0020 17F8 0057 1757 D400 8E45 4449 540D 0A03;
0030 D400 5C02 0732 3CD4 008E 3F03 D400 8E3E;
0040 03F8 0057 D400 AFD4 009E F800 B7F8 F5A7;
0050 D401 2630 30F8 03B7 F840 A7D5 F803 B746;
0060 52F8 00F4 A7D5 D3E2 9673 8673 93B6 83A6;
0070 46B3 46A3 3066 D3E2 1296 B386 A372 A6F0;
0080 B630 76D4 813E D5D4 81A4 D5D4 0087 46BF;
0090 FB03 3A8B D5D4 005C 0047 BA07 AAD5 D400;
00A0 5507 FB0D 32AC 47FF 413B A127 07A9 D5D4;
00B0 0055 F83E A8D4 0083 9F57 FB08 32D0 FB10;
00C0 32DF FB15 32E7 2888 32E7 17D4 0087 30B5;
00D0 88FB 3E32 B518 27D4 008E 1315 0330 B5D4;
00E0 008E 0D15 0330 AFF8 0D57 17F8 0A57 D400;
00F0 8E0D 0A03 D543 029C 4901 9D57 01DF 4B02;
0100 114C 0270 5302 5855 01C3 4402 3D42 0289;
0110 4502 9250 02A7 4D80 0054 02C3 0303 0303;
0120 0303 0303 0303 E7F8 03F3 3242 89F3 1732;
0130 3517 1730 26F8 01B8 F83C A8D8 72B3 72A3;
0140 E2D3 D400 5C02 F801 57D5 D400 55F8 00A8;
0150 A9E7 F830 F53B 6FF8 3AF5 336F 72FA 0FB9;
0160 89FE FEE2 5289 F4FE 5299 F4A9 1830 5188;
0170 3A79 72FB 0D3A 5119 D5FF 033B 78A9 D401;
0180 42D5 9AB7 8AA7 46A8 E788 F332 9CF8 03F3;
0190 329C 72BF D400 879F FB0A 3A88 D5D4 009E;
01A0 17F8 00B8 A8EA F803 F332 AF1A 1830 A672;
01B0 7398 3AB7 8832 BB2A 2830 AF47 5A1A FB0A;
01C0 3AA6 D5D4 014A 8932 DA2A 0AFB 0232 D92A;
01D0 0AFB 0A3A CA29 893A C91A D401 8203 D5D4;
01E0 014A 8932 F69A B78A A7D4 0186 0307 FB03;
01F0 32F6 2989 3AE9 D59A B78A A746 B846 A8E7;
0200 98F3 3210 88F3 3210 F803 F332 1017 3000;
0210 D5D4 014A 8932 359A B78A A7D4 01FB 0A0A;
0220 07FB 0332 2A17 2989 3A18 9A88 8AA8 4758;
0230 18FB 033A 2ED4 0182 03D5 C4C4 C4D4 014A;
0240 8932 530A FB03 3257 1A0A FB0A 3A43 2989;
0250 3A43 1AD4 0182 03D5 D400 951A 0ABF D481;
0260 A49F FB03 326F F8FF A727 873A 6930 5BD5;
0270 D402 92D4 8140 9F32 735A FB03 3285 FB10;
0280 3285 1A30 73F8 035A D5D4 0095 1AD4 0182;
0290 03D5 D401 F703 0397 BA87 AAD5 D400 95F8;
02A0 025A 1AF8 035A D5D4 014A D400 5C00 F840;
02B0 5289 32BC F733 BC89 FEFE 30BE F801 57D4;
02C0 0095 D5D4 0095 1AF8 06A7 0ABF FB03 32E2;
02D0 D402 E39F FB0A 3AC6 BFD4 02E3 2787 3AD9;
02E0 30C6 D5D4 81A4 D5
*
```

Program listing for 1802 Tiny Text Editor in UT4 format. The first column of numbers is the starting address of the following code for each line.

the editor with an SEP R5 instruction.

4. Table 3 lists the editor register assignments. R2 through R6 are assigned according to the RCA standard call and return technique and may be used by the I/O routines to call subroutines. Registers R0, R1 and RB through RF may be used for the I/O routines. If the I/O routines alter any of the registers R2 through RA, they should be saved and restored.

Also listed in Table 2 are the character codes that the editor echoes to the terminal in response to the back-space and cancel commands. These codes should be changed as required to achieve the indicated functions. ■

R0	Not Used
R1	Not Used
R2	Stack Pointer
R3	Program Counter
R4	Call Routine Program Counter
R5	Return Routine Program Counter
R6	Holds Return Address
R7	General Purpose
R8	General Purpose
R9	General Purpose
RA	Text Pointer
RB	Not Used
RC	Reserved for I/O (UT4)
RD	Reserved for I/O (UT4)
RE	Reserved for I/O (UT4)
RF	Reserved for I/O (UT4) RF.1 passes I/O character

Table 3. Register assignments.

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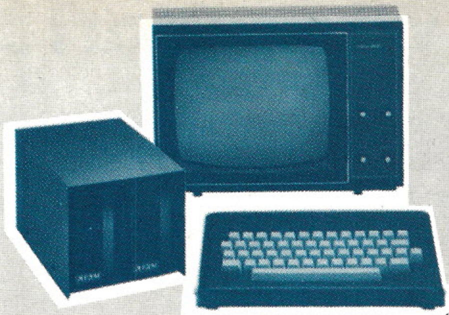

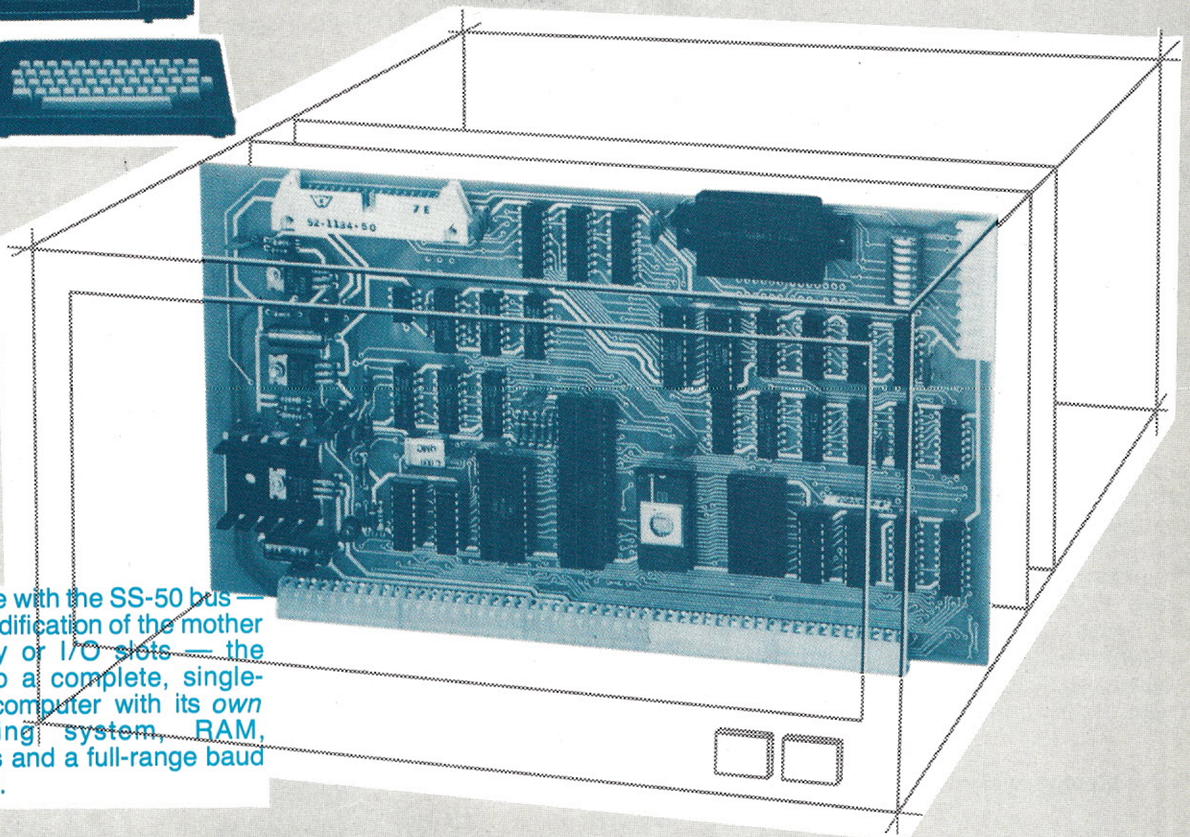

Fully compatible with the SS-50 bus — requiring *no* modification of the mother board, memory or I/O slots — the SBC/9™ is also a complete, single-board control computer with its *own* ROM operating system, RAM, peripheral ports and a full-range baud clock generator.

Make the SBC/9™ the heart of your computer and put to work the most outstanding microprocessor available, the 6809.

the Mighty 6809

Featuring more addressing modes than any other eight-bit processor, position-independent coding, special 16-bit instructions, efficient argument-passing calls, autoincrement/autodecrement and more, it's no wonder the 6809 has been called the "programmers dream machine."

Moreover, with the 6809 you get a microprocessor whose programs typically use only one-half to two-thirds as much RAM space as required for 6800 systems, and run faster besides.

And to complement the extraordinary 6809, the Percom design team has developed PSYMON™, an extraordinary 6809 operating system for the SBC/9™.

PSYMON™ — Percom SYstem MONitor

Although PSYMON™ includes a full complement of operating system commands and 15 externally callable utilities, what really sets PSYMON™ apart is its easy hardware adaptability and command extensibility.

For hardware interfacing, you merely use simple, specific device driver routines that reference a table of parameters called a Device Control Block (DCB). Using this technique, interfacing routines are independent of the operating system.

The basic PSYMON™ command repertoire may be readily enhanced or modified. When PSYMON™ first receives system control, it initializes its RAM area, configures its console and then 'looks ahead' for an optional second ROM which you install in a socket provided on the SBC/9™ card. This ROM contains your own routines that may alter PSYMON™ pointers and either subtly or radically modify the PSYMON™ command set. If a second ROM is not installed, control returns immediately to PSYMON™

- Provision for multi-address, 8-bit bidirectional parallel I/O data lines for interfacing to devices such as an encoded keyboard.
- A serial interface Reader Control output for a cassette, tape punch/reader or similar device.
- An intelligent data bus: multi-level data bus decoding that allows multiprocessing and bus multiplexing of other bus masters.
- Extended address line capability — accommodating up to 16 megabytes of memory — that does not disable the on-board baud rate clock or require additional hardware in I/O slots.
- On-board devices which are fully decoded so that off-card devices may use adjoining memory space.
- Fully buffered address, control and data lines.

The SBC/9™, complete with PSYMON™ in ROM, 1K of RAM and a comprehensive users manual™ costs just $199.95.

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Percom *'peripherals for personal computing'*

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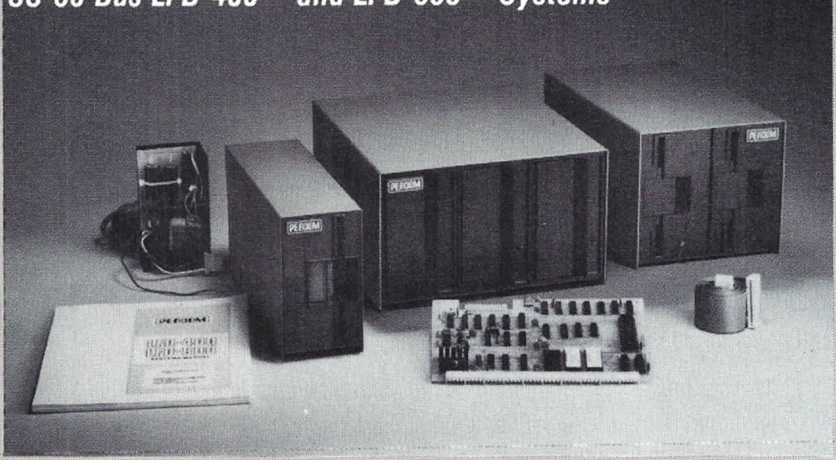
Welcome to Percom's Wide World



SS-50 Bus LFD-400™ and LFD-800™ Systems

Each LFD mini-disk storage system includes:

- drives with integral power supplies in an enamel-finished enclosure
- a controller/interface with ROM operating system plus extra ROM capacity
- an interconnecting cable
- a comprehensive 80-page users manual

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Low-Cost Mini-Disk Storage in the Size You Want.

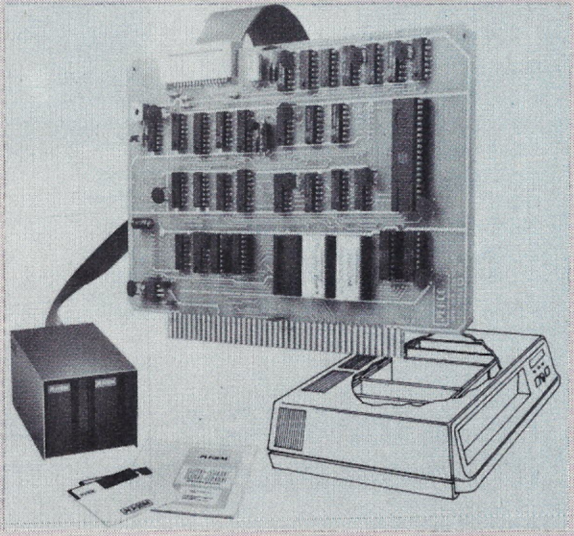
Percom LFD mini-disk drive systems are supplied complete and ready to plug in the moment they arrive. You don't even have to buy extra memory. Moreover, software support ranges from assembly language program development aids to high-speed disk operating systems and business application programs.

The LFD-400™ and -400EX™ systems and the LFD-800™ and -800EX™ systems are available in 1-, 2- and 3-drive configurations. The -400, -400EX drives store 102K bytes of formatted data on 40-track disks, and data may be stored on either surface of a disk. The -800, -800EX drives store 200K bytes of formatted data on 77-track disks.

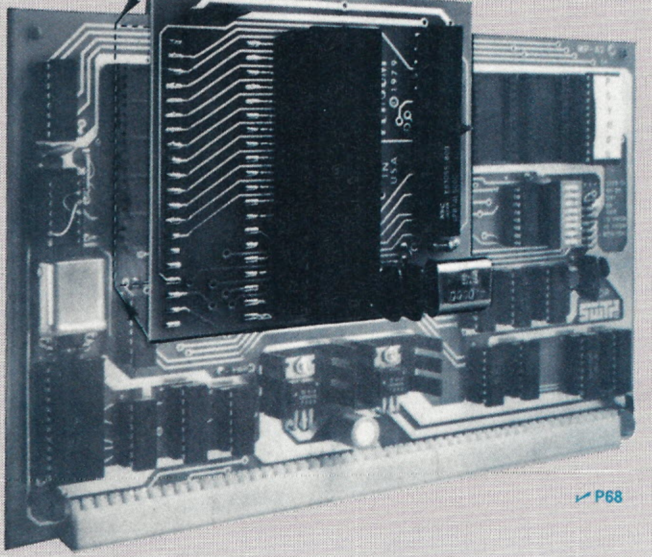
The LFD-1000™ systems (not pictured) have dual-drive units which store 800K bytes on-line. The LFD-1000™ controller accommodates two drive systems so that a user may have as much as 1.6M bytes on-line.

Mini-disk storage system prices:

MODEL	1-DRIVE SYSTEM	2-DRIVE SYSTEM	3-DRIVE SYSTEM
For the SS-50 Bus:			
LFD-400™	$ 599.95	$ 999.95	$1399.95
LFD-800™	895.95	1549.95	2195.95
For the EXORciser* Bus:			
LFD-400EX™	$ 649.95	$1049.95	$1449.95
LFD-800EX™	945.95	1599.95	2245.95
LFD-1000™	(dual) $2495.00	(quad) $4950.00	—



EXORciser Bus LFD-400EX™ -800EX™ Systems*



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Upgrade to 6809 Computing Power. Only $69.95

Although designed with the SWTP 6800 owner in mind, this upgrade adapter may also be used with most other 6800 and 6802 MPUs. The adapter is supplied assembled and tested, and includes the 6809 IC, a crystal, other essential components and user instructions. Restore your original system by merely unplugging the adapter and a wire-jumpered DIP header, and re-inserting the original components. Also available for your upgraded system is PSYMON™ (Percom SYstem MONitor), the operating system for the Percom 6809 single-board computer. PSYMON™ on 2716 ROM costs only $69.95. On diskette (source and object files), only $29.95.

Data Terminal & Two-Cassette Interface — the CIS-30+

P69

- Interface to data terminal and two cassette recorders with a unit only 1/10 the size of SWTP's AC-30.
- Select 30, 60 or 120 bytes per second cassette interfacing; 300, 600 or 1200 baud data terminal interfacing.
- Optional mod kits make CIS-30+ work with any microcomputer. (For MITS 680b, ask for Tech Memo TM-CIS-30+-09.)
- KC Standard/Bi-Phase-M (double frequency) cassette data encoding. Dependable self-clocking operation.
- Ordinary functions may be accomplished with 6800 Mikbug* monitor

Prices: Kit, $79.95; Assembled, $99.95. Prices include a comprehensive instruction manual. Also available: Test Cassette, Remote Control Kit (for program control of recorders), IC Socket Kit, MITS 680b mod documentation and Universal Adapter Kit (converts CIS-30+ for use with any computer).

of 6800 Microcomputing.

6800/6809 SOFTWARE

System Software

6800 Symbolic Assembler — Specify assembly options at time of assembly with this symbolic assembler. Source listing on diskette $29.95

Super BASIC — a 12K extended random access disk BASIC for the 6800 and 6809. Supports 44 commands and 31 functions. Interprets programs written in both SWTP 8K BASIC (versions 2.0, 2.2 & 2.3) and Super BASIC. Features: 9-digit BCD arithmetic, Print Using and Linput commands, and much more. Price $49.95

TOUCHUP™ — Modifies TSC's Text Editor and Text Processor for Percom mini-disk drive operation. Supplied on diskette complete with source listing $17.95

Operating Systems

INDEX™ — This easy-to-use disk-operating and file management system for 6800 microcomputers is fast. I/O devices are serviced by interrupt request. INDEX™ accesses peripherals the same as disk files — new devices may be added without changing the operating system. Other features: unlimited number of DOS commands may be added • over 60 system entry points • display only those files at or above user-specified file activity level • versions available for SWTP MF-68, Smoke's BFD-68 and Motorola's EXORciser*. Price $99.95

MINIDOS-PLUSX™ — An extension of the original MINIDOS™ for LFD-400™ mini-disk systems, MINIDOS-PLUSX™ manipulates files by six-character names. Supports up to 31 files. Resident commands include Initialize, Save, Allocate, Load, Files (directory list), Rename and Delete. Supplied on 2708 ROM with a minidiskette that includes transient utilities such as Copy, Backup, Create, Pack and Print Directory. Price .... $34.95.

PSYMON™ — Percom SYstem MONitor for the Percom single-board/SS-50-bus-compatible 6809 computer accommodates user's application programs with any mix of peripherals **without** modifying programs. PSYMON™ also features character echoing to devices other than the communicating device, sophisticated register and memory dump routines and more. Price (on 2716 ROM) .... $69.95.

WINDEX™ — Described in detail elsewhere on this page.

Business Programs

General Ledger — For 6800/6809 computers using Percom LFD mini-disk storage systems. Requires little or no knowledge of bookkeeping because the operator is prompted with non-technical questions during data entry. General Ledger updates account balances immediately — in real time, and will print financial statements immediately after journal entries. User selects and assigns own account numbers; tailors financial statements to firm's particular needs. Provides audit trail. Runs under Percom Super BASIC. Requires 24K bytes of RAM. Supplied on minidiskette with a comprehensive users manual. Price .... $199.95.

FINDER™ — This general purpose data base manager is written in Percom Super BASIC. Works wth 6800/6809 computers using Percom LFD-400™ mini-disk drive storage systems. FINDER™ allows user to define and access records using his own terminology — customize file structures to specific needs. Basic commands are New, Change, Delete, Find and Pack. Add up to three user-defined commands. FINDER plus Super BASIC require 24K bytes of RAM. Supplied on minidiskette with a users manual. Price $99.95

Mailing List Processor — Powerful search, sort, create and update capability plus ability to store 700 addresses per minidiskette make this list processor efficient and easy to use. Runs under Percom Super BASIC. Requires 24K bytes of RAM. Supplied on minidiskette with a users manual. Price $99.95.

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Development and debugging programs for 6800 μCs on diskette:

Disassembler/Source Generator	$30.95
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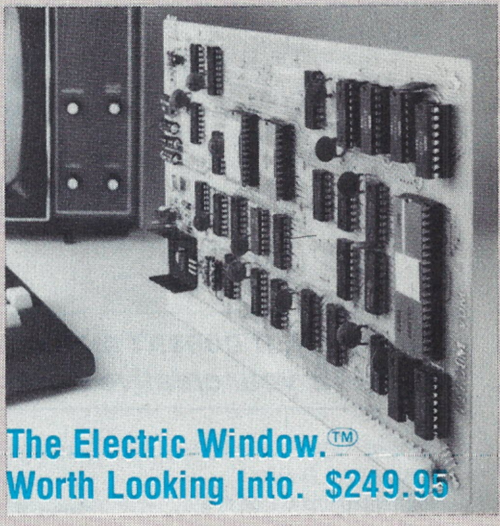
And 'looking into' is just what you do with the Electric Window™ as you peer right into memory space where characters are being input and manipulated. Display is memory-resident, programmable and generates up to 24 80-character lines.

Other features include:
- standard character generator plus provision for optional special character generator
- dual intensity, high-lighting alphanumeric display
- scrolling by a programmable register • programmable display positioning
- programmable interlaced or non-interlaced scan
- descenders on lower case letters • users manual with application instructions and listing of WINDEX™ driver.



The Electric Window.™ Worth Looking Into. $249.95

WINDEX™ is a fast video display driver program for the Electric Window™. WINDEX™ also features: program and keyboard control of character generators • displayable control characters — under program control • automatic scrolling • a driver routine for the parallel input keyboard feature of the Percom 6809 Single-Board Computer, the SBC/9™ • auto-linking to PSYMON™, the ROM operating system for the SBC/9™ • Prices: ROM version: $39.95; LFD-400™ compatible diskette (source and object files): $29.95. P71

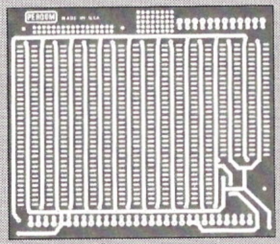
Now Available! the SBC/9™ MPU/Control Computer

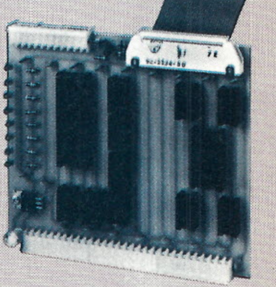
(Single-Board-Computer/6809) — stands alone as a control computer, but also compatible with the SS-50 bus for use as an MPU card. Includes PSYMON™ (Percom SYstem MONitor) in a 1K ROM and provides for additional 1K of ROM. Also includes 1K of RAM. Features: Super Port — provision for multi-address, 8-bit bidirectional data lines • an intelligent data bus for multi-level data bus decoding • an on-board 110-baud to 19.2 kbaud clock generator • extended address capability — to 16 megabytes — without disabling baud clock or adding hardware. And much more. Supplied with PSYMON™ and comprehensive users manual. Price $199.95. P82

See full page ad elsewhere in this magazine for all of the SBC/9™ features.

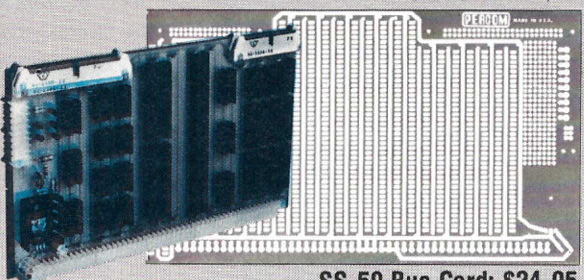
Full Feature Prototyping PC Boards

All of the features needed for rapid, straightforward circuit prototyping. Use 14-, 16-, 24- and 40-pin DIP sockets • SS-50 bus card accommodates 34- and 50-pin ribbon connectors on top edge, 10-pin Molex connector on side edge • I/O card accommodates 34-pin ribbon connector and 12-pin Molex on top edge





I/O Bus Card: $14.95



SS-50 Bus Card: $24.95

- I/O card is 1-¼ inches higher than SWTP I/O card • interdigitated power conductors • contacts for power regulators and distributed capacitance bypassing
- use wire wrap, wiring pencil or solder wiring • tin-lead plating over 2-oz copper conductors wets quickly, solders easily
- FR4-G10 epoxy-glass substrate.

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The BASICs of Computer Art

Ultimately, it doesn't matter whether you use an expensive plotter or an ancient Teletype Model 15, your creative works must obey the rules of geometry, which stay about the same.

Leonard Kilian
37 Burnham Drive
West Hartford CT 06110

Sooner or later you'll probably be struck by the urge to draw pictures using your microcomputer. And pretty soon you'll be able to afford to. Everyone has some seed of creativity just waiting to germinate. The computer can not only sprout this embryo, but also cause it to flourish. Once you start with an idea—any idea—it is amazing how your imagination can interact with the computer, expose you to more elaborate constructs and lead you to concepts you never thought of in the beginning.

If you want to draw pictures with some degree of sophisitication, you ought to provide for the following items.

Hardware. You can use any of a number of devices to draw your picture. Of course, the quality and character of the drawing depend on whether you use a plotter, typewriter, printer, vector scope or whatever.

$$a = x_b - x_a \qquad b = x_c - x_d \qquad e = x_c - x_a$$
$$c = y_b - y_a \qquad d = y_c - y_d \qquad f = y_c - y_a$$

then:

$$\Delta = a \times d - b \times c;$$
$$t = \frac{d \times e - b \times f}{\Delta}, \text{ if } \Delta \neq 0;$$
$$t' = \frac{a \times f - c \times e}{\Delta}, \text{ if } \Delta \neq 0.$$

Example 1.

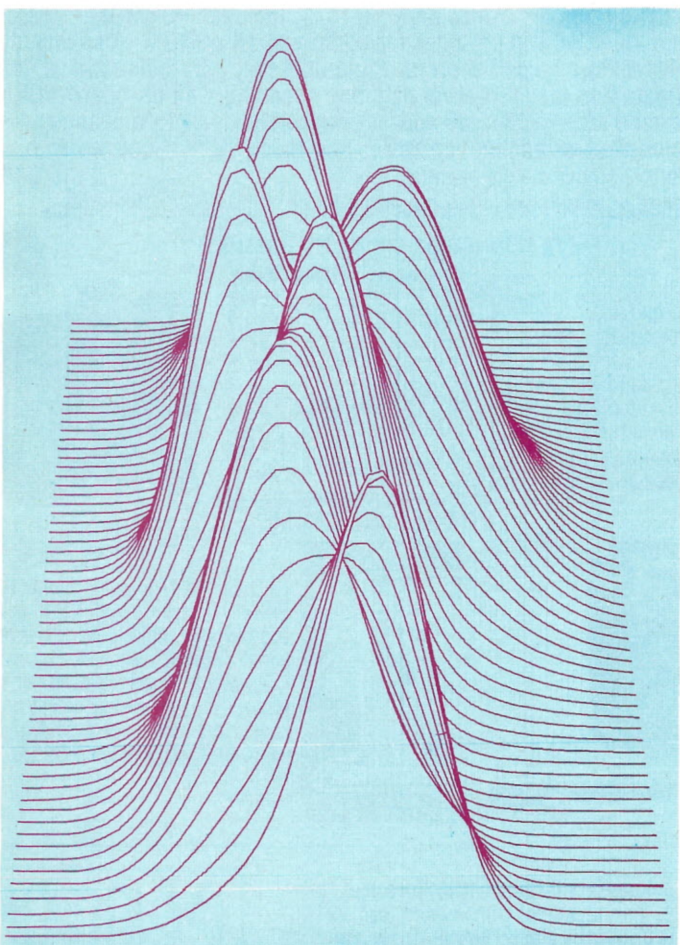

Fig. 1.

Drawing a line segment. In almost all cases, drawings will be composed of line segments connecting predetermined points. If you can draw a line from one point to another, then you'll be able to draw any complicated drawing, within the physical constraints of your system.

Library of subroutines. Instead of attempting to draw the picture illustrated in Fig. 1 as your first project, you might be advised to start with more basic figures. Starting with a straight line segment, you'll quickly be able to draw rectangles, circles and other figures. Then you can use these to draw more complex figures. Once you write a program to draw a composite figure, you need not reinvent that program. In this way you will soon have a library of subroutines that will make your drawings quicker, more satisfying and under your command.

Planning. You should have an initial plan for developing a picture. As you get feedback from the results produced by the computer, you may want to modify your original idea. An orderly record of what you have already written will help you to create the effect you want in your new work. But be flexible. Some of your better pictures may be the result of serendipity.

Patience. Give yourself time to work up to the masterpiece you have in mind. First develop the workhorse routines. Review what you produced last month, then two months ago, so you can appreciate how far you have really come. Once you get started, you'll be surprised how soon you'll be getting satisfaction from your drawings.

Creativity. You have it! Develop it; work with it; share it! Let your imagination interact with your results. Study other people's works. Be aware of the world around you.

In this article I'll assume that you have satisfied the conditions of the first two items. I'll barely get into the third. Fulfillment of the remaining items is your responsibility and your pleasure.

As a starting point, I'll discuss the intersection of two line segments. This is a necessary and useful facility used repeatedly in computer graphics.

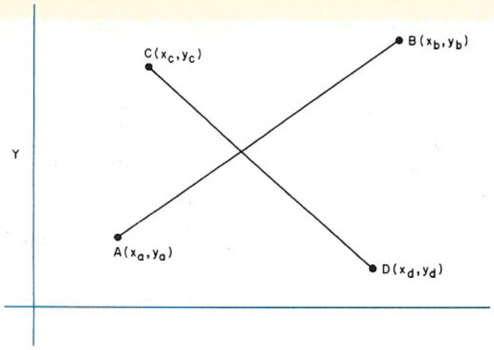

Fig. 2.

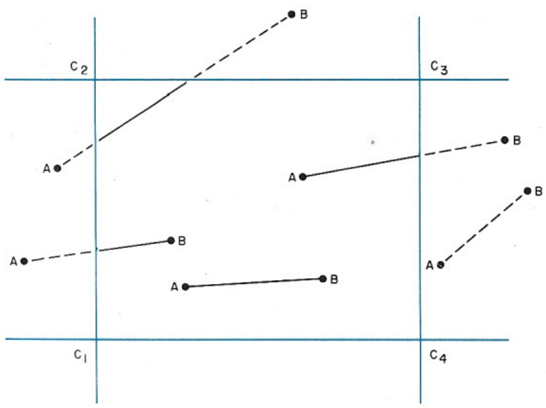

Fig. 3.

$$x = (x_b - x_a) \times t + x_a$$
$$y = (y_b - y_a) \times t + y_a$$

Equation 1.

$$x = (x_b - x_a) \times t + x_a \qquad x = (x_d - x_c) \times t' + x_c$$
$$y = (y_b - y_a) \times t + y_a \qquad y = (y_d - y_c) \times t' + y_c$$

Equation 2.

$$(x_b - x_a) \times t + (x_c - x_d) \times t' = (x_c - x_a)$$
$$(y_b - y_a) \times t + (y_c - y_d) \times t' = (y_c - y_a)$$

Equation 3.

(a) $a \times x + b \times y = e$

$c \times x + d \times y = f$

then:

(b) $x = \dfrac{d \times e - b \times f}{\Delta}$ and $y = \dfrac{a \times f - c \times e}{\Delta}$

where $\Delta = a \times d - b \times c$.

Equation 4.

$$(x_i, y_i) = ((x_b - x_a) \times t + x_a, (y_b - y_a) \times t + y_a)$$

Equation 5.

Then this technique will be applied to the bounding of lines within the drawing surface. Finally, it'll be used again to shade a polygonal figure by a set of parallel lines.

Intersection of Line Segments

There are several ways to find the intersection of two line segments. The approach I'll use is to set up the equation of a straight line in parametric form. As you'll see later, this method has properties that are very useful for our other applications.

1. Equation of a straight line in parametric form. Suppose a line passes through the points A and B with the coordinates (x_a,y_a) and (x_b,y_b) as in Fig. 2. Then a pair of equations can be formed in terms of a single variable, t. For any value of t, the corresponding values of x and y are the coordinates of a point on the line passing through A and B. Also, when $t = 0$, the point is A; when $t = 1$, the point is B. For values of t between 0 and 1, the point lies between A and B. Otherwise, the point does not lie on the segment. Equation 1 shows these two formulas.

2. Intersection of two lines. Let us examine the intersection of the two lines shown in Fig. 2—the first going through the point A (x_a,y_a) and the point B (x_b,y_b), the second going through C (x_c,y_c) and D (x_d,y_d). The parametric equations for these two lines are shown in Equation 2.

In order to find the point of intersection of these two lines, we set the equations for x equal to each other and do the same for y. This gives us the pair of equations shown in Equation 3.

By solving for t and t′ and substituting for t in Equation 1, the point of intersection (x_i,y_i) can be found. Moreover, if $0 \leqslant t \leqslant 1$, then (x_i,y_i) lies on the segment $\overline{AB}$; if $0 \leqslant t' \leqslant 1$, the point lies on the segment $\overline{CD}$.

3. Solving a pair of simultaneous equations. We shall not concern ourselves here with the general solution of n simultaneous equations in n unknowns, which can lead to some very interesting and involved numerical analyses. However, the solution of two equations in two unknowns is rather simple and concise. Let us start with two completely general equations in x and y (see Equation 4). If $\Delta = 0$, then obviously there can be no solu-

```
N = number of intersections side AB makes with the sides of the
     rectangle defining the drawing surface.
K = side of the rectangle, K goes from 1 to 4. Side1 = C1C2, side2 =
     C2C3, side3 = C3C4, side4 = C4C1.
U,V = coordinates of the points of intersection that AB makes with
      the sides of the rectangle. At most, two points of intersec-
      tion are possible.
N = 0
For K = 1 to 4
        If AB intersects side K:
          Then: N = N + 1
                U(N),V(N) = coordinates of point of intersection
        If N = 2:
          Then: Exit.
Next K
If N = 0:
  Then: If A is inside:
          Then: Draw from A to B.
          Else: (Draw no line.) Return
If N = 1:
  Then: If A is inside:
          Then: Draw from A to point of intersection.
          Else: Draw from point of intersection to B.
        Reverse inside/outside designation for next point.
If N = 2:
  Then: If A is inside:
          Then: (Impossible) Write error message. Return.
          Else: Draw from first point of intersection to second.
Move coordinates of point B to A.
Return.
```

Fig. 4.

Program A. Scissoring program. This program draws all line segments interior to a rectangle with $C_1 \leq x \leq C_2$ and $C_3 \leq y \leq C_4$. After the first point, the second end-point of the last segment is assumed to be the first end-point of the next segment.

```
10  DIM X(21),Y(21),R(20),S(20),T(20),U(20),V(20)
20  DIGITS = 2
30  DATA  C1,C3,C1,C4,C1,C4,C2,C4,   : Coordinates of corners of
          C2,C4,C2,C3,C2,C3,C1,C3    :  the rectangle.
40 INPUT X1, Y1                      : First point.
50 GOSUB 900          (INSIDE)       : Determine if first point is
                                     :  inside or outside.
60 INPUT X2, Y2                      : Second end-point.
70 GOSUB 400          (SCISSOR)      : Draw this segment.
80 GOTO 60                           : Repeat for next segment.

(INTERS)
100  I9 = 0                          : Intersection indicator.
110 A = X2 - X1
120 B = X3 - X4
130 C = Y2 - Y1
140 D = Y3 - Y4
150 E = X3 - X1
160 F = Y3 - Y1
170 Z1 = .0001                       : Tolerance for parallelness.
180 G = A*D - B*C                    :
190 IF ABS(G) < Z1 THEN 290
200 T1 = (D*E - B*F)/G
210 IF T1 < 0 THEN 310
220 IF T1 > 1 THEN 310
230 T2 = (A*F - C*E)/G
240 IF T2 < 0 THEN 330
250 IF T2 > 1 THEN 330
260 X9 = X1 + A*T1                   : Point of intersection is
270 Y9 = Y1 + C*T1                   :  (X9, Y9).
280 RETURN
290 I9 = 9                           : Lines are parallel.
300 RETURN
310 I9 = 1                           : Intersection not on first
320 GOTO 230                         :  segment.
330 I9 = 2                           : Intersection not on second
340 RETURN                           :  segment.
400 N = 0                            : N = number of intersections.
420 RESTORE
430 FOR K = 1 TO 4                   : K records side being checked.
440 READ X3, Y3, X4, Y4              : Coordinates of side.
450 GOSUB 100         (INTERS)       : Check for intersection.
460 IF I9 <> 0 THEN 510
470 N = N + 1
```

```
960 GOSUB 1000        (LIFT)
970 RETURN
980 S1= 1
990 RETURN

(LIFT)
1000 Lift pen.
1010 Move to (E1, F1).
1020 Drop pen.
1030 PRINT "LIFT TO "; E1, F1
1040 RETURN

(DRAW)
1100 Move pen to (E2, F2).
1110 PRINT "MOVE TO "; E2, F2
1120 RETURN
```

Program B. Polygon-shading program.

```
1500 PRINT "NO. OF SIDES ";          : N = number of sides.
1510 INPUT N                         : Maximum N is 20.
1520 FOR I = 1 TO N                  : Input coordinates of vetices.
1530 INPUT X(I), Y(I)
1540 NEXT I
1550 X(N+1) = X(1)
1560 Y(N+1) = Y(1)
1570 GOSUB 2000       (SHADE)
1600 GOTO 1500

(SHADE)
2000 PRINT "SLOPE ";
2010 INPUT M
2020 PRINT "DISTANCE APART ";
2030 INPUT D
2040 GOSUB 2300       (MINMAX)       : Find YMIN (Y7), YMAX (Y8).
2050 FOR Y = Y7 TO Y8 STEP D
2060 K = 0                           : K = number of intersections.
2070 FOR I = 1 TO N
2080 GOSUB 2400       (LINE)         : Construct line passing throug
                                     :  (0,Y) with slope = M.
2100 IF I9>=2 THEN 2150              : If none, go to next side.
2110 K = K + 1
2120 R(K) = X9                       : Store point of intersection
2130 S(K) = Y9                       :  and t.
2140 T(K) = T1
2150 NEXT I
2160 IF K = 0 THEN 2270
2170 IF K - INT(K/2)*2 = 0 THEN 2200
2180 K = K-1
```

```
480 U(N) = X9                              : Store coordinates of the
490 V(N) = Y9                              :  point of intersection.
500 IF N >= 2 THEN 810                     : No more than 2 are possible.
510 NEXT K
520 IF N9 <> 0 THEN RETURN                 : Exit for INSIDE routine.
540 IF N <> 0 THEN 650                     : N=0 means no intersection.
550 IF S1<> 0 THEN 610                     : S=0 means point A is inside.
560 E2 = X2
570 F2 = Y2
600 GOSUB 1100          (DRAW)             : Draw to (E2, F2).
610 X1 = X2                                : Make the second point the
620 Y1 = Y2                                :  first point of the next segment.
630 RETURN
650 IF N <> 1 THEN 810
660 IF S1<>0 THEN 740
670 E1 = X1
680 F1 = Y1
690 GOSUB 1000          (LIFT)             : Lift pen to (E1, F1)
700 E2 = U(1)
710 F2 = V(1)
720 S1= 1                                  : End-point now outside.
730 GOTO 600                               : Draw this part.
740 E1 = U(1)
750 F1 = V(1)
760 GOSUB 1000          (LIFT)
770 E2 = X2
780 F2 = Y2
790 S1= 0                                  : End-point now inside.
800 GOTO 600                               : Draw this part.
810 IF S1= 0 THEN 880
820 E1 = U(1)
830 F1 = V(1)
840 GOSUB 1000          (LIFT)
850 E2 = U(2)
860 F2 = V(2)
870 GOTO 600                               : Draw this part.
880 PRINT "ERROR"
890 GOTO 610
(INSIDE)
900 X2 = -1
910 Y2 = -1
915 N9 = 1
920 GOSUB 400           (SCISSOR)
925 N9 = 0
930 IF N<>1 THEN 980
940 S1= 0
945 E1 = X1
950 F1 = Y1
```

```
2190 IF K = 0 THEN 2275
2200 GOSUB 2500         (SORT)         : Sort on t.
2210 FOR I = 1 TO K/2
2220 J = 2*I -1
2230 E1 = R(J)
2240 F1 = S(J)
2245 GOSUB 1000                        : Lift pen to XJ, YJ.
2250 J = J + 1
2255 E2 = R(J)
2258 F2 = S(J)
2260 GOSUB 1100         (DRAW)         : Draw to (XJ,YJ)
2265 NEXT I
2270 REM   GET NEXT LINE
2275 NEXT Y
2280 RETURN

(MINMAX)
2300 Y7 = Y(1) - M * X(1)
2310 Y8 = Y7
2320 FOR I = 2 TO N
2330 YO = Y(I) - M * X(I)              : YO is the y-intercept.
2340 IF YO < Y7 THEN Y7 = YO
2350 IF YO > Y8 THEN Y8 = YO
2360 NEXT I
2370 RETURN

(LINE)
2400 X1 = 0
2410 Y1 = Y
2420 X2 = 1
2430 Y2 = Y + M
2440 X3 = X(I)
2450 Y3 = Y(I)
2460 X4 = X(I+1)
2470 Y4 = Y(I+1)
2480 GOSUB 100          (INTERS)
2490 RETURN

(SORT)
2500 FOR I = 1 TO K-1
2510 FOR J = I+1 TO K
2520 IF T(I) < T(J) THEN 2620
2530 T9 = R(I) : R(I) = R(J) : R(J) = T9
2560 T9 = S(I) : S(I) = S(J) : S(J) = T9
2590 T9 = T(I) : T(I) = T(J) : T(J) = T9
2620 NEXT J
2630 NEXT I
2640 RETURN
```

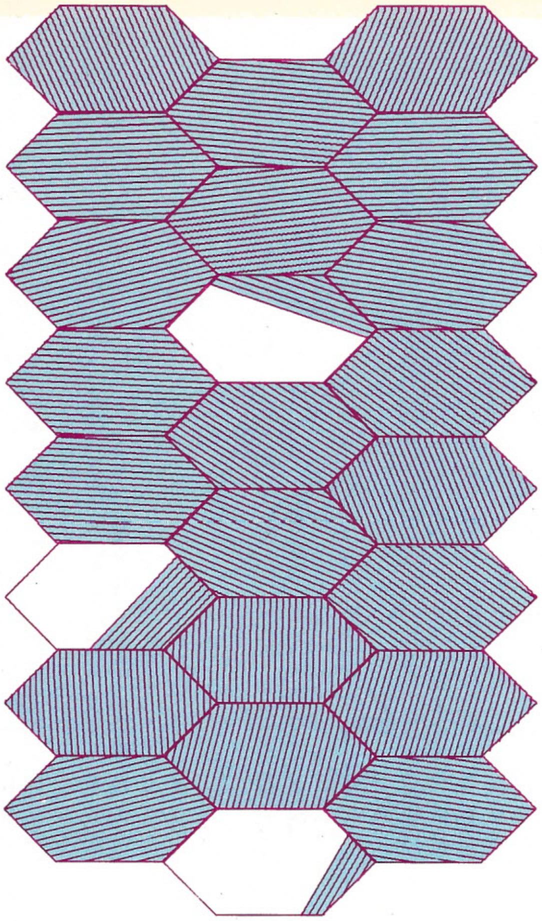

Fig. 5.

No. of Intersections	A inside	A outside
0	from A to B	no part
1	from A to intersection	from intersection to B
2	impossible	from first intersection to second intersection

Table 1.

tion. This happens when the two lines are parallel or coincide.

4. Solving for t and t′. We can apply formulas in Equation 4b to find the intersection of the segments $\overline{AB}$ and $\overline{CD}$. In Equation (4a) we set it up as in Example 1.

It is then easy to determine if the point of intersection lies on either, or both, of the segments. That point is shown in Equation 5.

Scissoring

Since the physical surface on which you're plotting is limited, it is necessary to determine whether the line segment $\overline{AB}$ lies within the area available. If you draw a line from A to B, it is possible that either one end-point or both lie outside the region. Then keeping track of the intersections that $\overline{AB}$ makes with the boundary defining the drawing surface enables you to draw just that portion of the segment lying inside the rectangle.

If the rectangle is defined by the points C_1, C_2, C_3, C_4, and the line segment to be drawn is from point A to point B, Fig. 3 illustrates the different situations that may arise. Table 1 shows how to draw that part of $\overline{AB}$ lying inside the rectangle.

A logic chart following the principles of structured programming as described by Dr. Lance Leventhal in the February 1978 issue of *Kilobaud* ("Why Structured Programming?" p. 84) is given in Fig. 4. Also a BASIC implementation for this algorithm is given in Program A.

Lining a Polygonal Figure

This is a simple technique for shading a figure or for representing solids by the use of lines. Fig. 5 is an example of a shaded polygon. Other dramatic effects can be achieved by varying the angle of the lines and their density.

If you can draw a single line through the polygon so that only those parts of the line inside the figure are drawn, then you can add as many as you want, as close to each other as you want, to complete the picture.

To start, set up a simple data structure for the polygon—namely, an (N + 1) by 2 matrix, where N is the number of vertices. The elements of the i^{th} row are the coordinates of the i^{th} vertex of the polygon. The N + 1^{st} set is a repetition of the first. Therefore, each side of the polygon can be found by taking two consecutive rows of the matrix.

The procedure will be to take a line, search for an intersection with each side, record the result and then draw the segments that lie inside the polygon. This logic is elaborated in Fig. 6. A BASIC version of this program is given in Program B.■

```
Input: m = slope of lines
       d = distance separating lines.
Find:  ymin = smallest y-intercept of lines passing through polygon
       ymax = largest y-intercept.
For y = ymin to ymax by d
        k = 0 (k is the number of intersections)
        For i = 1 to N (N is the number of sides)
             Construct a line passing through (0,y) with slope = m.
             If the line intersects side i:
                  Then:  k = k + 1
                         Store x_k, y_k, t_k.
        Next i.
        If k = 0:
          Then: Exit.
        If k is odd:
          Then: Print error message.
                Exit.
        If k is even:
          Then: Sort on t.
                For i = 1 to k/2
                         j = 2 × i − 1
                         Lift pen of x_j,y_j.
                         j = j + 1
                         Draw to x_j,y_j.
                Next i.
Next y.
Return.
Minmax.
ymin = y(1)
ymax = y(1)
For i = 2 to N:
        y-intercept = y(i) − m × x(i)
        If y-intercept<ymin:
          Then:  ymin = y-intercept.
        If y-intercept>ymax:
          Then: ymax = y-intercept.
Next i.
Return.
Sort.
For i = 1 to k − 1:
        For j = i + 1 to k:
             If t(i)≥t(j):
                  Then:  Switch t(i), t(j).
                         Switch x(i), x(j).
                         Switch y(i), y(j).
        Next j.
Next i.
```

Fig. 6. Logic chart for shading a polygon.

Software with Manual / Manual Alone

DIGITAL RESEARCH

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**Z80 is a trademark of Zilog, Inc.
***UNIX is a trademark of Bell Laboratories.
****WHATSIT? is a trademark of Computer Headware.
†CP/M for Heath, TRS-80 Model I and PolyMorphic 8813 are modified and must use especially compiled versions of system and applications software.
††PolyMorphic 8813 CP/M scheduled for September 15 release.

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MICROPRO

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Software with Manual / Manual Alone

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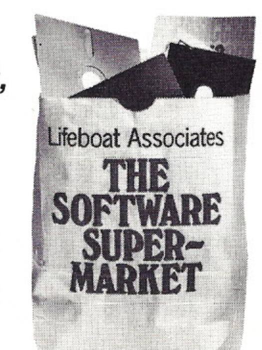
Shopping List No.6



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Reverse Video from OSI's 540 Board

Black on white video enhances your graphics displays.

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Do you ever tire of looking at white characters on a black background? Wouldn't it be nice to have black on white as well as white on black displays? Well, if you own an OSI system equipped with the 540 video board, you can add reverse video to your 540 video board with the addition of a toggle switch and two lengths of wire. The toggle switch will allow you to switch between white characters displayed on black or black characters displayed on white. Many graphics displays will be more dramatic when displayed against a white background. Photo 1 shows the entire OSI graphics character set as it appears displayed on a white background.

Fig. 1 is the video driver portion of the 540 video board's circuitry. The added switch is shown within the dotted lines. When the switch is open, the display operates normally, displaying white characters on the black background. When the switch is closed, the 7403, wired as an inverter, is bypassed, allowing the video signal from the character generator to be output without being inverted, thus giving you reversed video over the entire display.

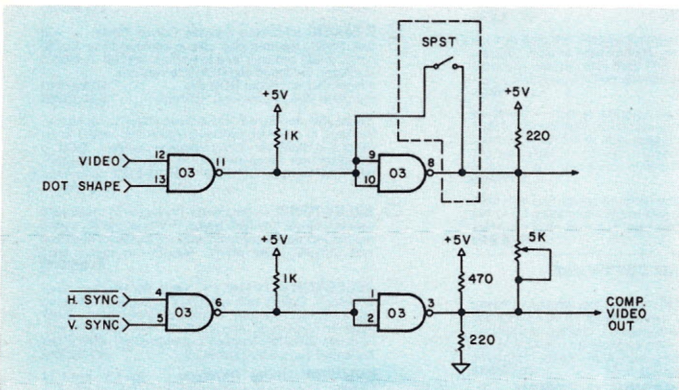

Fig. 1. Video driver portion of OSI 540 video board.

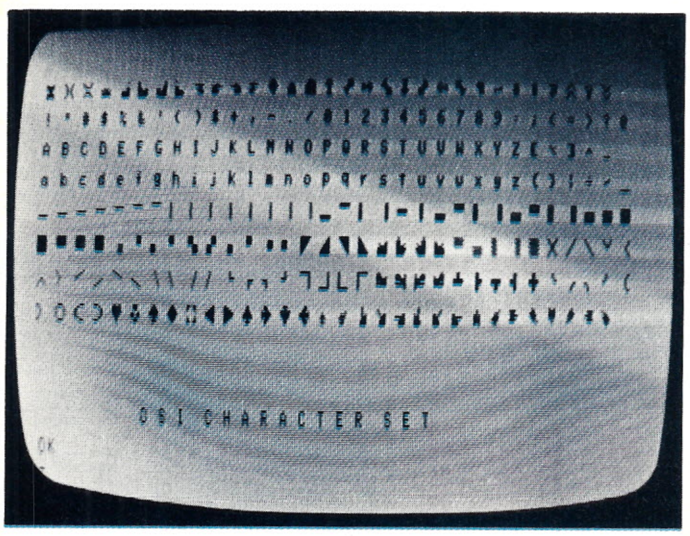

Photo 1. OSI graphics character set in reversed video mode.

OSI has provided solder pads at pins 8 and 10 of the 7403 IC, shown in Fig. 1, which makes the addition of the switch neat and simple.

Board Modification

Photo 2 shows the 540 video board. In order to locate the 7403, a description of the 540 board's real estate is in order. The large IC near the center of the photo is the character generator. Above the character generator you can see the ribbon cable that goes to the keyboard. To the right of the character generator is a 7400 NAND IC, and below this IC is the 7403 we are looking for. Between the 7400 and the 7403 you can see a disk capacitor. Just below this capacitor you will see two solder pads at pins 8 and 10 of the 7403 IC. (Note: There are also two solder pads on the other side of the 7403 chip at pins 1 and 3. Do not use these.)

After you have located the proper solder pads, the next step is to determine where you wish to place the toggle switch. Since I own a C2-4P, I mounted my switch at the rear of the

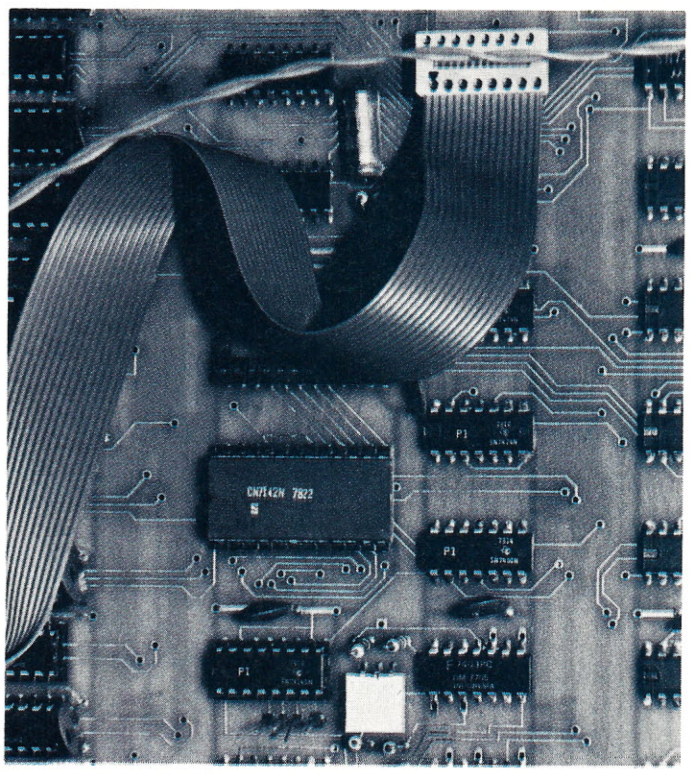

Photo 2. OSI 540 video board. Solder pads can be seen at pins 8 and 10 of 7403 IC.

case, close to the power switch. You may wish to locate the switch at a position more convenient for you. Next, run a length of wire from each solder pad to each switch terminal as shown within the dotted lines of Fig. 1. Photo 3 shows the wiring on my system between the solder pads at the 7403 chip and the toggle switch on the rear panel.

At this point you are ready to test your work. If you removed any circuit boards, replace them with the power off, of course, and power up the system. Depending upon the state of the switch—open or closed—your display should be either normal or reversed, respectively. Try the switch in both positions to be sure you have both normal and reversed video displays.

In the reversed video mode it may be necessary to adjust the contrast and brightness controls of your video monitor for optimum performance. If you are unable to obtain the above results, turn off the power and recheck your wiring. Make sure you use the proper solder pads as shown in Photos 2 and 3; also check your toggle switch for proper wiring.

I have been using this feature on my system for several months now and find it enhances my graphics displays. If you try it, I'm sure you will enjoy this feature, too.■

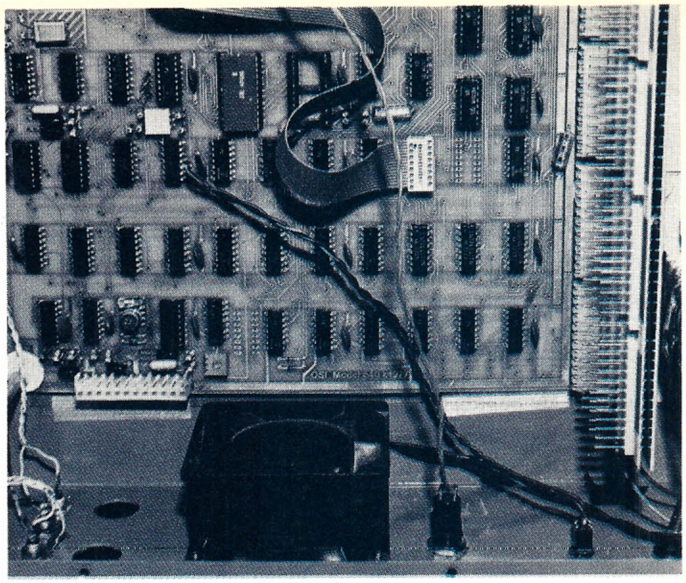

Photo 3. Final installation as it appears on the author's system.

Free Libraries

Your local public library is free—but why not have your own free private library?

Name withheld by request

If you've been involved with personal computers for more than about five minutes, then you know that the name of the game is information. You need to know about the latest developments in hardware, what new software has come out in the past month and who's selling what at the lowest prices. You need reference books to provide the fundamentals of programming and hardware design. You need expert evaluations of new products to help you decide what to buy. You need *information.*

The main problem with information is that it costs money . . . a lot of money. On one three-foot shelf by my desk, I have almost $400 worth of computer books. The shelf right below that has about $200 worth of magazines. Neither shelf is full. New hardware is no problem; just keeping up with the new information is what costs money.

Fortunately, there are ways to cut down on the cost of keeping up on all the changes in our field. As a matter of fact, you can cut things down to the point where there is almost no cost involved at all. How about half-price books? You can even get people to *pay* you to read about your hobby. Would you like to get information on all the latest chips months before they show up in the magazines? Read on.

Magazines

Let's take a look at the easiest way to get free information. Every magazine in the field has a "reader-service" card stuck somewhere in it. Most of them don't even need a stamp. Yet every month, a large percentage of readers just ignore that card and pass up piles of free stuff. That reader-service card is your best friend in the world. For just a few minutes of your time, it will repay you with a daily mailbox full of free goodies. You read the ads anyway, right? If you're like me, that's the first thing you do when you receive a new issue.

Here's what you do: When a magazine comes in the mail, rip out a reader-service card, find a pen and go from page 1 through the end of the magazine reading the ads (which you do anyway, remember?). Every time you see a product that looks interesting, circle the number on the card. Don't feel guilty about circling a large number of numbers . . . those companies have already set aside the money to pay for the replies and only expect a small percentage of people to buy anything. Circle away! You have nothing to lose.

In addition to the ads in the main part of the magazine, there's another fruitful area that is often overlooked: the "new products" section. Many times those new products will have reader-service numbers attached to them. Often, the big companies such as Intel and Motorola will have write-ups in this section but no ads in the main part of the magazine. When you circle one of the big boys' numbers, you'll generally get on a mailing list. That means that you'll be getting information on new chips, application notes, all kinds of things without even having to ask. Sometimes you'll even get (say it softly) *free samples.*

Now, stick a stamp on that card and drop it into the box. Be sure to look first, though; some of the magazines have postage-paid cards, and it would be a shame to waste a perfectly good stamp on something that's free.

Occasionally you'll see something that you want the dope on real quickly. In those cases you'll be best served by a letter. It only takes a couple of minutes to type up a letter on clean paper that'll get a fast reply. Never write in longhand on a piece of notebook paper. You want the company to think that you're actually going to buy whatever it is that they're selling. The only way that they can tell anything about you is from your letter; sound straight and important to receive the red-carpet treatment.

Books

Magazines can't be your only source of information. We all have to have some fundamental reference books on hand all the time. I don't know how many times I've gone back to the *TTL Cookbook* or the BASIC manual that goes with my system.

As you become more advanced in this field, you want to know more, which means more books. The sad thing is that technical books have always been outrageously priced. The problem is, I guess, that tech books don't sell many copies compared to a typical "best-seller," so the prices have to be higher. There are also more costs involved with editing and producing a book with many charts and tables that must be completely accurate. Finally, they've got us over a barrel . . . we *have* to have the darn books.

Once again, though, there are a few secrets you can use to save some money. Just about every college in the country has some sort of computer course. That means that they have told the college bookstore to stock books for those courses. Now, that alone doesn't get you inex-

pensive books. What does is that most students sell their books back to the bookstore when they're through with them. The bookstore then turns around and sells the used books the next quarter for 30 to 50 percent off the new price.

To get in on this you have to be fast; those used books are the first ones to be sold. So write to all the local colleges and get their catalogs (which are free, and you should have them anyway). Look through the catalogs for courses on the topics that interest you. Just before a quarter (or semester or whatever) starts, make a trip to the bookstore at the college and check out the book situation. You'll find books on everything from beginning BASIC to how to write compilers and operating systems.

Timing is everything on this deal. You have to get there before the students do, but after all the books are on the shelves. The best time to make your trip is the weekend before school starts. This not only gives you all day Saturday to browse through a number of stores, but it generally beats the rush of students. Local situations may be different, and it may take a couple of tries before you get the timing down. Who knows, you may even see a course you want to take.

Another technique for getting inexpensive standard reference works is the library book sale. In any reasonably large town, or even a small town if it has a university, there is likely to be an annual book sale put on by the public library (or university library). Some of these sales are "real big deals." In Chicago there's the annual Brandiess Book Sale. People come from all over the country to get in on this. For a couple of bucks you can quickly fill out your reference shelf. I picked up a *CRC Handbook* for three bucks. This is a four-inch-thick, 20-pound book that contains just about every physical constant there is. At another sale I purchased *Standard Math Tables* (also by CRC) for 50 cents.

Obviously, timing is crucial at a book sale. Get there early, stand in line with some friends and be willing to do some pushing and some shoving.

There's another method of getting books cheaply that requires a certain amount of skill and more time than the other methods: writing book reviews. This technique only works with *new* books or ones that are standards in other fields and so may be new to hobbyists. I don't have too much experience in this particular technique but have made twice as much money as I've spent on books by writing reviews.

There is one other advantage of writing book reviews if you do them on a regular basis. Publishers will send you *free copies* of newly published books in your field. I have one friend who reviews science-fiction books, and each month a number of publishers send him boxes full of review copies of their latest offerings. He has piles and piles of books in his attic and takes every opportunity to give them away. Wouldn't it be nice to have to do that with computer books?

The trick is, of course, to review regularly. Since the market is rather limited in terms of "professional magazines," your best bet is to associate with some local computer club that has a newsletter. If they are at all typical, they'll be absolutely *desperate* for material. I have trouble putting out a six-page newsletter each month for a club with nearly 100 members. A page of book reviews would be like manna from heaven.

Once you've done a few month's worth of reviewing, send copies of your column to all the publishers whose material you've reviewed. In your cover letter, politely ask if they would be willing to send you review copies of new books as they come out. Be sure to tell them how your column reaches "virtually every computerist in the area." Try to sound as important as possible, but don't actually *lie* to them. You should soon be getting your share of free books. If, by chance, you're feeling generous, you might mention that all the books received will go into the club's reference library or be donated to a local high school. Big companies love that sort of line.

They Call This Work?

There's one more way that you can cut down on your information costs, but it's rather slow and indirect. If you are a computer professional of some sort, chances are you can deduct a good portion of your "hobby" expenses as professional advancement. This will require the services of an income tax consultant to be sure that what you do is completely legal and aboveboard.

I happen to make a living (of sorts) from writing about the computer field. I take off *all* (just about) of the money that I spend on computers and related materials. I even depreciate my hardware just as the big boys depreciate their mega-buck systems. Get yourself some expert advice and see how much you can take off for having fun.

As you can see, you don't really have to spend so much money after all to keep up in our field. You just have to be a little sneaky and keep your eyes open for the right chances. I think that anybody who tries can actually make money by having fun. ■

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PET's Machine Language Monitor

From France comes a review and analysis of PMLM.

PET's Machine Language Monitor allows you to easily introduce hexadecimal machine-language programs into PET's memory and to execute them. The programs may also be machine-language subroutines used through BASIC by means of USR or SYS commands. The monitor also includes debugging facilities, program storage and retrieval on cassettes, and comfort facilities such as relative branch displacement calculation or base conversions. Nineteen different commands are provided.

The Machine Language Monitor consists of a BASIC program that works in an 8K configuration, plus a machine-language module that resides normally between 033A and 03FF (second cassette buffer; if the second cassette is to be used, this module has to be relocated).

PMLM Commands

Commands may be classified in four categories:

- Fundamental entry commands
- Fundamental execution commands
- Utility commands
- "Comfort commands"

Frontiers between categories are not always clear. In fact, the only fundamental commands are @, $ and G. All others are bonus commands.

Any command consists of a single character arbitrarily (or not?) chosen, followed by RETURN. Between commands, hexadecimal numbers are entered and interpreted according to preceding command(s). Since these numbers are treated as character strings, when the system expects 4/2 digits you have to enter 4/2 digits. Use the standard INST/DEL key in case of typing errors. Moreover, nonhex digits may be accepted but are interpreted erroneously. For instance, G is interpreted as 16: G1 gives $16 \times 16 + 1$. Any entry must be terminated by RETURN, except in some rare cases. If you type RETURN alone, the system comes back to BASIC Monitor (exit from PMLM).

Fundamental Entry Commands

@ (Address): Sets address mode. The next 4-digit hexadecimal entry will become the *current address*. It will be displayed together with its contents.

$ (Data): Sets data mode. The next 2-digit hexadecimal entry will replace the contents of the current address, and the new state will be displayed.

+: Increments current address. The new address and contents will be displayed.

−: Decrements current address. The new address and contents will be displayed. Note: + and − commands don't change the mode. To enter a program, you type: @, RETURN, start address, RETURN, $, RETURN, first data, RETURN, +, RETURN, second data, RETURN, +, RETURN, etc.

M (Quick Memory Setting): The preceding procedure of entering a program is somewhat tedious because of the RETURNs. M offers a simplification and also packs the listing. To enter a program you type: @, RETURN, start address, RETURN, M, RETURN, first data, RETURN, second data, RETURN, etc. When you hit RETURN, new data replace the old on the screen, and the current address is incremented automatically. M accepts three subcommands that can be entered instead of data:

+: Skips to next address without modifying current data.

J (Jump): Computes a relative branch displacement (see below).

N (End): Leaves M mode.

Fundamental Execution Commands

G (Go): Executes machine-language program, starting at current address. (For example, to execute from 03C0, type: @, RETURN, 03C0, RETURN, G, RETURN.

R (Restart): Resumes program execution after a STOP or a BREAKPOINT (restarts from PC value when interruption occurred).

S (Step): Executes *one* instruction in user's program starting at current address. You should not single-step a break or the highest level RTS from your program.

Utility Commands

L (List): Lists contents of consecutive memory locations starting at current address + 1. For example, to list from $03A0, type: @, RETURN, 039F, RETURN, L, RETURN.

If during an L command you press the OFF/RVS key, the listing will be slowed down (as in a BASIC listing operation). If you press the shift key, listing will cease (i.e., the display will be "frozen" to allow you to observe it. When the display is frozen, your pressing the shift key a second time will resume listing).

If you press the N key without RETURN while the display is frozen, PMLM will exit from the command and wait for the next one; so a ? and the cursor will come back. But the display will be ? N ■ (cursor) since, to exit, you have typed N. You must delete that N before entering the

Hex	Dec	Register
33A	826	Y
33B	827	X
33C	828	A
33D	829	P (status register)
33E	830	PC (low)
33F	831	PC (high)

Table 1.

next command.

#: Disassembly, starting from current address (which should contain an op code). If an illegal op code is found, it is listed as a dash, and search continues at the next address. SHIFT and N (not RVS) work as in the L command (i.e., SHIFT stops disassembly, a new SHIFT makes it resume, N exits from the command).

W (Watch): The @ command works in a way similar to the KIM Teletype mode: The memory location is read once and then displayed. The W command allows you to work as in the KIM LED-display mode: the contents of the current address are continuously read, and the display changes "in real time." This is especially useful if the considered location is an I/O port; you can verify that a switch is correctly connected. It is particularly instructive to "watch" location $0203 while depressing various keys on PET's keyboard. Try it. To end the "watch" mode, use the shift key.

*: Display current PC. Useful during a break in the middle of an execution, after you have displayed various locations. It reminds you where you are.

?: Displays current mode (address or data) and recalls current address. Useful if you don't remember what preceding command does with the mode.

J (Jump): Computes a relative branch displacement, assuming that the displacement should reside in current address (i.e., the branch operation code is in current address − 1). The system seeks the target address. When you have entered it, the displacement is computed, displayed and written into memory. If the branch is out of range, a diagnostic is given.

For example, suppose that in $03B0 you want to implement a BNE $03C0. You put D0 in $03B0; + sets you to $03B1. Now J, and to the Target Address? question you answer 03C0. You obtain the display 0351 0E, Note that for still more convenience, this command will also work in the M mode.

Cassette Utility Commands

It is possible to store a program on PET's incorporated cassette and to retrieve it by name. The files are PET-formatted (not KIM or Kansas City format).

←: Stores a module on cassette. After you hit the RETURN key, the system asks you: NAME, END ADDRESS. You enter the name you want for the file (without quotes) and the last address you want to save. The system assumes that the beginning address is the current address. To save a program under the name PROG, from $03A0 to $03BF, you have the dialogue in Example 1.

↑: Retrieves a module from cassette. The system asks you: NAME, FIRST ADDRESS. You enter the name of the wanted file (or its first letters as usu-

```
           @ RETURN
           03A0 RETURN
PET says:  03A0 XX
           ← RETURN
PET says:  NAME, END ADDRESS?
           PROG, 03BF RETURN
PET says:  PRESS PLAY AND RECORD ON TAPE #1
```

Example 1.

```
@ RETURN
03D0 RETURN
M RETURN

4C RETURN      03D0 4C
D0 RETURN →    03D1 D0
03 RETURN      03D2 03  (you are implementing an endless loop. That's too
N RETURN                bad!)
03D0 RETURN
G RETURN
RUN
STOP
PET answers: BREAK in 145
```

Example 2.

Listing 1.

```
5 HX$="0123456789ABCDEF"
10 MO=4 :AC$="0000" :AC=0 :POKE 223,0
15 PRINT"□DATA LOADING" :GOSUB 650
17 PRINT"□"
20 INPUT A$
25 IF A$="L" GOTO 450
30 IF A$="@" GOTO 130
35 IF A$="&" GOTO 17
40 IF A$="G" GOTO 135
45 IF A$="←" GOTO 550
50 IF A$="$" GOTO 150
55 IF A$="↑" GOTO 600
60 IF A$="+" GOTO 160
65 IF A$="M" GOTO 700
70 IF A$="-" GOTO 180
75 IF A$="*" GOTO 155
80 IF A$="X" GOTO 770
85 IF A$="H" GOTO 790
90 IF A$="J" GOTO 800
95 IF A$="=" GOTO 900
100 IF A$="R" GOTO 990
102 IF A$="S" GOTO 320
105 IF A$="?" GOTO 880
110 IF A$="W" GOTO 995
112 IF A$="#" GOTO 1250
115 GOSUB 200
120 IF MO=2 THEN POKE AC,DA
125 GOSUB 500 :GOTO 20
130 MO=4 :GOTO 20
135 SS=0 :POKE 223,0 :POKE 222,0
140 POKE 252,0 :GOSUB 980
145 SYS(911) :GOTO 680
150 MO=2 :GOTO 20
155 AC=256*PEEK(831)+PEEK(830) :GOTO 170
160 AC=AC+1
170 GOSUB 350
175 GOSUB 500 :GOTO 20
180 AC=AC-1 :GOTO 170
200 NB$=RIGHT$(A$,MO)
210 GOSUB 250
220 IF MO=4 GOTO 240
230 DA$=NB$ :DA=NB :RETURN
240 AC$=NB$ :AC=NB :RETURN
250 MU=1 :NB=0
255 FOR I=1 TO MO
260 CH=ASC(RIGHT$(NB$,I))
270 IF CH>57 THEN CH=CH-7
280 NB=NB+MU*(CH-48)
290 MU=MU*16 :NEXT I
295 RETURN
300 D1=INT(DA/16) :R1=DA-D1*16
305 DA$=MID$(HX$,(D1+1),1)+MID$(HX$,(R1+1),1)
310 RETURN
320 POKE 223,64 :IF SS=1 GOTO 990
330 SS=1 :GOTO 140
350 AC$="" :VV=AC
360 FOR I=1 TO 4
370 V1=INT(VV/16)
380 RS=VV-16*V1
390 AC$=MID$(HX$,(RS+1),1)+AC$
400 VV=V1
410 NEXT I
420 RETURN
450 PRINT"□"
460 AC=AC+1 :GOSUB 350 :GOSUB 500
465 IF PEEK(516)<>1 GOTO 460
470 GOSUB 490
475 IF PEEK(515)=22 GOTO 20
480 IF PEEK(516)=1 GOTO 460
485 GOTO 475
490 TT=TI
492 IF (TI-TT)<30 GOTO 492
495 RETURN
500 AB=AC :GOSUB 970
510 GOSUB 300
520 PRINTAC$,DA$ :RETURN
550 INPUT"FILE-NAME,ENDADDRESS";FL$,NB$
555 GOSUB 250 :AF=NB :POKE 243,122 :POKE 244,2
560 OPEN 1,1,1,FL$ :PRINT#1,AC :PRINT#1,AC$
565 FOR AD=AC TO AF
570 DA=PEEK(AD)
575 PRINT#1,DA :GOSUB 1600 :NEXT AD
580 GOSUB 1620 :CLOSE 1 :GOTO 20
```

```
600 INPUT"FILE-NAME,FIRSTADDRESS";FL$,NB$
605 OPEN 1,1,0,FL$ :INPUT#1,AC :INPUT#1,AC$ :IF NB$="-" GOTO 615
610 GOSUB 250 :AC=NB :AC$=NB$
615 INPUT#1,DA
620 IF ST>0 GOTO 640
625 POKE AC,DA
630 GOSUB 500
635 AC=AC+1 :GOSUB 350 :GOTO 615
640 CLOSE 1 :GOTO 175
650 OPEN1,1,0,"PMLMDATA"
655 FOR I=832 TO 962 :INPUT#1,N :POKE I,N :NEXT I
660 GOSUB 1200 :CLOSE 1
662 DATA " "," "," "," "," "," ",",X)","),Y",",X",",X",",Y"," ",),",Y"
665 DATA 160,0,177,247,133,247,96
670 FOR I=1017 TO 1023 :READ N :POKE I,N :NEXT I
675 POKE 539,92 :POKE 540,3 :RETURN
680 IF PEEK(252)=0 GOTO 20
685 AC=256*PEEK(831)+PEEK(830)    :GOSUB 350 :PRINT"BREAK IN PC = ",AC$
690 PRINT"▒REGISTERS (ORDER Y X A P )▒" :FOR I=826 TO 829
695 DA=PEEK(I) :GOSUB 300 :PRINTDA$ :NEXT I :GOTO 20
700 MO=2 :MM=1
705 INPUT A$ :IF A$="J" GOTO 800
710 IF A$="N" THEN MM=0 :GOTO 130
715 IF A$="+" GOTO 730
720 GOSUB 200
730 POKE AC,DA
740 PRINT"TTT"
745 GOSUB 500
750 AC=AC+1 :GOSUB 350
760 GOSUB 500 :GOTO 705
770 MO=4 :INPUT NB$
772 IF NB$ = "N" GOTO 20
775 GOSUB 250
780 PRINT NB :GOTO 770
790 INPUT AC
795 GOTO 170
800 MO=4 :INPUT "TARGET ADDRESS";NB$
810 GOSUB 250 :NB=NB-AC-1
820 IF ABS(NB)<=127 GOTO 840
830 PRINT"!!OUT OF RANGE!!" :GOTO 20
840 DA=NB AND 255 :POKE AC,DA
845 IF MM=1 THEN MO=2 :GOTO 745
850 GOTO 125
880 IF MO=2 GOTO 890
885 PRINT"ADDRESS" :GOTO 125
890 PRINT"DATA" :GOTO 125
900 MO=4 :INPUT "ENDADDR.,BYTE1,BYTE2,BYTE3";NB$,O1$,O2$,O3$
905 GOSUB 250 :AF$=NB$ :AF=NB
910 AB=AC :GOSUB 970 :GOSUB 300
915 IF DA$<>O1$ GOTO 955
920 AB=AC+1 :GOSUB 970 :GOSUB 300
925 IF O2$="/" GOTO 935
930 IF DA$<>O2$ GOTO 955
935 AB=AC+2 :GOSUB 970 :GOSUB 300
940 IF O3$="/" GOTO 950
945 IF DA$<>O3$ GOTO 955
950 GOSUB 350 :PRINT"==="+AC$
955 IF AC>=AF GOTO 20
960 AC=AC+1 :GOSUB 350 :GOTO 910
970 AH=INT(AB/256) :AL=AB-256*AH :POKE 247,AL :POKE 248,AH
975 SYS(1017) :DA=PEEK(247) :RETURN
980 AH=INT(AC/256) :AL=AC-256*AH
985 POKE 830,AL :POKE 831,AH :RETURN
990 POKE252,0 :SYS(889) :GOTO 680
995 MO=4 :PRINT "TT" :GOSUB 500
997 IF PEEK(516)=0  GOTO 995
998 GOTO 20
1200 DIM MN$(151),MA%(151),NC(13),G$(13),D$(13),B$(2)
1210 FOR I=0 TO 151 :INPUT#1,MN$(I) :NEXT I
1215 FOR I=0 TO 150 :INPUT#1,MA%(I) :NEXT I
1235 FOR I=0 TO 13 :INPUT#1,NC(I) :NEXT I
1240 FOR I=0 TO 13 :INPUT#1,G$(I) :NEXT I
1245 FOR I=0 TO 13 :READ D$(I) :NEXT I :RETURN
1250 PRINT"J"
1260 GOSUB 350 :AB=AC :GOSUB 970 :GOSUB 300 :DD$=DA$ :AA$=AC$
1270 GOSUB1400 :GH$=G$(AM) :DR$=D$(AM) :NN=NC(AM)
1280 B$(1)="  " :B$(2)="  " :AN=AC+NN+1 :BB$="" :IF NN=0 GOTO 1310
1290 FOR I=1 TO NN :AB=AC+I :GOSUB 970
1300 GOSUB300 :B$(I)=DA$ :BB$=DA$+BB$ :NEXT I
1310 IF AM<>11 GOTO 1340
1320 IF DA>127 THEN DA=DA-256
1330 AC=AC+DA+2 :GOSUB 350 :BB$=AC$
1340 PRINT AA$+"  "+DD$+" "+B$(1)+" "+B$(2)+" "+"    "+NM$+"  "+GH$+BB$+DR$
1350 AC=AN :IF PEEK(516)<>1 GOTO 1260
1360 GOSUB 490 :GOSUB 490
1370 IF PEEK(515)=22 GOTO 20
1380 IF PEEK(516)=1 GOTO 1260
1390 GOTO 1370
1400 MA%(151)=DA :FOR I=0 TO 151
1410 IF (MA%(I) AND 255)=DA THEN J=I :GOTO 1430
1420 NEXT I
1430 NM$=MN$(J) :AM=INT(MA%(J)/256) :RETURN
1600 IF PEEK(625)>=170 THEN GOSUB 1620
1610 RETURN
1620 POKE 59411,53 :T=TI
1630 IF (TI-T)<6 GOTO 1630
1640 RETURN
```

al—e.g., PR or PRO would work for the above file) and the first address where PET should write the program. This means that you have an *automatic-translation* feature if the address you give is not the same as the original (e.g., if you give 03A5 for the above file). Notice that a pure *move* is performed; branch addresses are not corrected according to the displacement. On the contrary, if you want to put the program at its original address, you may answer, instead of an address: –, which means "get the address on the tape." For example, PRO, – retrieves the above file and puts it in its original place. As soon as the file is read, it is listed, buffer by buffer. Note: The last displayed address is the last address on file +1.

Comfort Commands

&: Clears screen.

X (Base X): Converts to decimal. This is useful, for instance, to poke a program into memory. The numbers must be in decimal. The command is repetitive: it always waits for a new number to convert. You type N to exit. Note: The numbers are considered as addresses, so you must input 4-digit hex numbers (with leading zeros if necessary).

H (Hexadecimal): Converts to hexadecimal. This is useful to enter a number you know in decimal form. When you have entered a number, this number becomes the current address. The number must be ⩽65535.

= (search =): This command allows you to search a particular pattern in memory, between current address and a final address. The search pattern may consist of up to three bytes. To answer a question such as, "Where do I have a JSR to $305F?" give 20, 5F, 30 as a pattern. The second and third bytes may be made "indifferent." This allows you to answer a question such as, "Where do I have a jump into zero page?" You give 4C, /, 00 as a pattern. The system asks the question: END ADDRESS, BYTE 1, BYTE 2, BYTE 3? Your answer could be: 03FF, 20, 5F,

Subroutines	
200-240	translate last data or address hex entry into its decimal equivalent
250-295	hex-to-decimal conversion
300-310	decimal-to-hex conversion for 2-digit data
350-420	decimal-to-hex conversion for 4-digit address
500-520	visualization of an address and its contents
650-675	entry of machine-language modules into memory
970-975	extraction of the contents of a given address (PEEK replacement)
980-985	setup of execution starting address
490-495	1/2 second delay
1600-1610	examine if tape buffer is near full
1620-1640	start cassette motor
1200-1240	take permanent data from cassette
Modules	
5-112	main branch table
115-125	digit entry
130	@ command
135-145	G command
150	$ command
155	* command
160	+ command
170-175	visualization
180	− command
320-330	S command
450-485	L command
550-580	← command (save a file on cassette)
600-640	↑ command (retrieve a file from cassette)
680-695	execution epilogue
700-760	M command
770-780	X command
790-795	H command
800-850	J command
880-890	? command
900-960	= command
990	R command
995-998	W command
1250-1430	# command

Table 2.

Dec	Hex	Name	Use
254	FE	SAVX	save stack pointer on interrupt
252	FC	IND	set to 0 at beginning of execution; set to nonzero on break or interrupt
247	F7		low part of wanted data address; later, contains fetched data
248	F8		high part of wanted data address
255	FF	SAVSP	save stack pointer on leaving BASIC to execute user's M-L program.
223,222	DE,DF	STEP,STEP1	single-step mode indicators

Table 3.

30. A / instead of a looked-for byte means "indifferent." The system prints = = = address each time it finds the wanted pattern.

System Use—Machine-Language Program Debugging

The most interesting feature of PMLM is the way it allows execution debugging of machine-language programs. Register contents may be examined and preset via a memory zone used as a register image. Register-image addresses are shown in Table 1.

The stack pointer can't be examined so easily, and it *should not* be modified. Anyway, address $00FF contains a copy of S in its state while calling the assembly-language program from BASIC; address $00DE contains a copy of S when the break or the interrupt which caused the present observation occurred.

Registers may be preset before an R or a G command by simply writing into $033A, etc., using an M command. Note that when a program starts (G), the flag register is set to all zeros. This obliges you to set the flags according to your needs in the program itself. Before an R, you can preset the flags; but be very cautious about D and I flags.

Breakpoints and Stops

Besides step-by-step execution, you have two debugging tools. You can easily implement breakpoints in your programs. You simply implement a BRK (= break) instruction at the place(s) you want. When the program arrives at a breakpoint, a message is printed and register contents are displayed:

```
BREAK IN PC = ----
REGISTERS (Y X A P SEQUENCE)
--
--
--
```

Notice that, in fact, the number given in PC = is break address + 2. If you use an R command, execution will resume at break address + 2. While in break, you have the control to visualize any location, to preset registers, and so on.

But another feature is provided. In effect, if your program loops endlessly in a zone where you have not implemented breaks, it seems that the only solution is to turn off the PET (with loss of memory). Not at all! Simply press the RUN/STOP key and you regain control. Try Example 2.

You type CONT and obtain a display analogous to that of a break. Then you can do anything PMLM allows—to see registers, memory locations, and so on. This can not work only if your endless loop occurs while you are in interrupt-inhibit mode. But in such a case, no PET function works at all since display is not refreshed nor keyboard scanned.

Tips for Machine-Language Programming

Program location. Now that you have a system to implement machine-language programs, it is important to know where to locate them. The problem is that a "safe" area is needed: an area that will not be disturbed by BASIC operations.

```
                         *** LISTING 2 ***

                  ; PMLM  M-L MODULES
                  ;
                        ORG $Ø33A ;LOCATE IN 2ND CASSETTE BUFFER
Ø33A              REGIM BSS 6     ;REGISTER IMAGE: Y,X,A,P,PCL,PCH
                  ;
                  ;INTERRUPT ROUTINE
Ø34Ø A5 DE        INTER LDA STEP ;TEST IF STEP
Ø342 FØ ØC              BEQ INTE2;IF NO GO TO OTHER CAUSE
Ø344 8D 4E E8           STA IER  ;IF YES DISABLE TIMER INTERRUPT
Ø347 AØ ØØ              LDY #Ø   ;NEXT INTERRUPTS
Ø349 84 DE              STY STEP ;WILL SURELY NOT BE
Ø34B 84 DF              STY STEP1;DUE TO SINGLE STEP
```

```
034D F0 0D              BEQ BREAK;GOTO BREAK ENTRY POINT
034F EA                 NOP
0350 D8           INTE2 CLD
0351 A5 FC              LDA IND  ;IF WE ALREADY BEGAN TO DEAL WITH
0353 D0 37              BNE SCRN ;STOP GO TO SCREEN INTERRUPT
0355 AD 03 02           LDA KEY  ;LOOK AT KEYBOARD($203)
0358 C9 04              CMP #4   ;IS STOP KEY DEPRESSED?
035A D0 30              BNE SCRN ;NO GO TO SCREEN INTERRUPT
                  ;
                  ;BREAK ENTRY POINT
035C D8           BREAK CLD      ;CLEAR FLAGS TO ALLOW NORMAL
035D 58                 CLI      ;SYSTEM OPERATION
035E 85 FC              STA IND  ;INTERRUPT DEAL INDICATOR
0360 86 FE              STX SAVX ;SAVE CURRENT STACK-POINTER
0362 A0 FA              LDY #$FA           ;LOOP
0364 BD 01 01     LP8   LDA $101,X         ;TO
0367 99 40 02           STA REGIM-$FA,Y    ;BUILD
036A E8                 INX                ;REGIS
036B C8                 INY                ;-TER
036C D0 F6              BNE LPB            ;IMAGE
036E A6 FF              LDX SAVSP;RETRIEVE ORIGINAL STACK-POINTER
0370 BD 02 01           LDA $102,X   ;PUSH ORIGINAL
0373 48                 PHA          ;RETURN ADDRESS
0374 BD 01 01           LDA $101,X   ;TO PREPARE A
0377 48                 PHA          ;SIMULATED RETURN
0378 60                 RTS          ;TO BASIC
                  ;
                  ;R COMMAND ROUTINE
0379 78           RSTRT SEI      ;INHIBIT INTERRUPTS
037A A6 FE              LDX SAVX ;RETRIEVE INTERRUPT STACK-POINTER
037C 9A                 TXS      ;RESTORE SP
037D A0 FA              LDY #$FA           ;RESTORE
037F B9 40 02     LPR   LDA REGIM-$FA,Y    ;STACK WITH
0382 9D 01 01           STA $101,X         ;(POSSIBLY
0385 E8                 INX                ; MODIFIED)
0386 C8                 INY                ;REGISTER
0387 D0 F6              BNE LPR            ;IMAGE
0389 4C AB 03           JMP EXIT ;GO TO TIMER SETTING
038C 4C 85 E6     SCRN  JMP $E685;GO TO OWN PET'S INTERRUPT ROUTINE
                                 ;TO DEAL WITH SCREEN AND KEYBOARD
                  ;
                  ;G COMMAND ROUTINE
038F 78           INIT  SEI      ;INHIBIT INTERRUPTS WHILE MANIPULATING
0390 BA                 TSX      ;THE STACK
0391 86 FF              STX SAVSP;SAVE ORIGINAL STACK-POINTER


0393 A9 00              LDA #0       ;ZERO INITIAL VALUE
0395 8D 3D 03           STA REGIM+3 ;OF FLAG REGISTER
0398 A0 06              LDY #6         ;LOOP TO
039A B9 39 03     LPI   LDA REGIM-1,Y ;PUSH
039D 48                 PHA            ;REGISTER IMAGE
039E 88                 DEY            ;ONTO
039F D0 F9              BNE LPI      ;THE STACK
03A1 A9 40              LDA #<INTER ;SET
03A3 8D 19 02           STA $219     ;INTERRUPT
03A6 A9 03              LDA #>INTER ;VECTOR
03A8 8D 1A 02           STA $21A     ;TO $0340(INTER)
03AB A5 DF        EXIT  LDA STEP1  ;TEST IF WE ARE IN SINGLE STEP MODE
03AD F0 11              BEQ JM     ;IF NO GO TO NORMAL USER EXECUTION
03AF 85 DE              STA STEP   ;IF YES SET STEP INDICATOR
03B1 A9 C0              LDA #$C0   ;ENABLE 6522 TIMER 1
03B3 8D 4E E8           STA IER    ;INTERRUPT
03B6 A9 18              LDA #$18   ;PREPARE A 24US
03B8 8D 44 E8           STA $E844  ;DELAY
03BB A9 D0              LDA #0     ;AND
03BD 8D 45 E8           STA $E845  ;START TIMER
03C0 4C 7E E6     JM    JMP $E67E  ;GO TO ROM ROUTINE ENDING BY AN RTI
                  ;
                  ;ROUTINE TO GET DATA IN MEMORY,WHERE PEEK DOESN'T GO
                        ORG $03F9
03F9 A0 00        GETD  LDY #0     ;ZERO Y FOR INDIRECT ADDRESSING
03FB B1 F7              LDA ($F7),Y;ADDRESS OF WANTED DATA IS IN $F7,$F8
03FD 85 F7              STA $F7    ;WANTED DATA ARE PUT IN $F7
03FF 60                 RTS
```

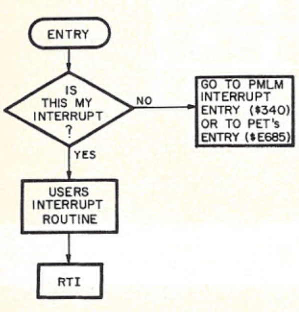

Fig. 1. Interrupt routine outline.

For instance, you will use PMLM to write a machine-language subroutine. Then you will load a BASIC program that calls it (with SYS or USR). Of course you want the loading operation to leave your machine-language program undisturbed, since you wish to use it.

Two basic methods to obtain a save area may be proposed.

1. The 2nd cassette buffer. If the 2nd cassette is not used, 192 bytes are free from $033A (826) to $03FF (1023). Notice that PMLM has assembler modules that occupy part of this zone so that only $03C3-$03F8 are free. If needed, the assembly-language modules may be relocated.

2. Tell BASIC not to use all available memory. This can be done in two ways. If you have memory expansion, you can install it at an address that leaves a "hole" in memory space. On system reset, BASIC will "think" that RAM is finished when it finds the hole. For instance, if you have 4K to add to an 8K PET, you can use the select line for block 3 (addresses $3000 to $3FFF) and leave a hole for addresses $2000 to $2FFF. BASIC will think that the last RAM address is $1FFF.

A second way is to "tell" BASIC where memory stops. This is done by POKEing a last address in locations 134 and 135. To tell BASIC in an 8K machine that it has 6.75K (and so reserve 1.25K for M-L programs), immediately after reset you type: POKE 135, 27. Then, addresses 1800 to 1FFF become safe and available for your machine-language programs.

Use of interrupts. Since PET uses interrupts (every 60th of a second) to refresh the screen and scan the keyboard, and since PMLM uses them for the STOP feature, the user must be cautious in using interrupts. In any case, his routine must obey principles outlined in Fig. 1.

PMLM Listings

Listing 1 is the BASIC listing. There are no REMs for memory saving. Main subroutines or modules are shown in Table 2.

Listing 2 gives the machine-language modules, fully commented. The zero-page locations used are shown in Table 3.

Memory occupation. Without the disassembler, 3400 bytes are free in an 8K PET. This allows the reservation of 2K or more for user's machine-language programs. With the disassembler, 1600 bytes are free. This allows at least reservation of 1.25K as mentioned earlier.

Program loading. The cassette contains two files: the program file (PMLM-E) and a data file (PMLMDATA).

When the program is loaded by means of a RUN command, it automatically goes to read the data file, which is the next one on the tape, and writes: DATA LOADING.

When the cursor appears, everything is ready. ■

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A Big Switch for the H17

Installing a simple toggle switch lets you equalize wear in your Heath dual-disk system.

Soon after starting to use the Heath H17 dual disk drive, I became aware that the left drive, which is designated System Zero (SY0:), was getting much more of a workout than the right drive, designated System One (SY1:).

To even out the wear and to make the drives easily interchangeable in case one of them failed, some simple method of swapping them was desirable. One of the local Heath Users' Group (HUG) members has replaced the programming plugs with DIP switches and swaps drives every month. The instruction manual states that the drives can be quickly unbolted and physically swapped in case of trouble.

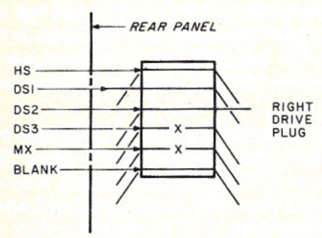

Fig. 1. Right-drive-plug configuration.

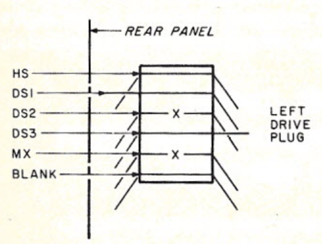

Fig. 2. Left-drive-plug configuration.

Although these methods are workable, it was John Smith, one of the long-time owners of the drive, who came up with a simpler solution. By installing a DPDT switch in the center of the front panel, it is easy to wire into the programming plugs and obtain a system swap in one easy flip of the switch.

I rushed home and went to work and soon had such a switch installed and working in my system. I was quite proud of my handiwork until the next time I saw John. I mentioned that with just one switch and six wires his switch system worked fine on my drive. He said that was nice, but he could not understand why I needed six wires since he only needed four.

Not being an electronics genius, I couldn't see how anyone could get by with only four wires. Finally, John drew the schematic, which showed my six wires. In John's schematic two of the wires were just jumpers on the back of the switch! So, what I'm going to share with you is not only John Smith's idea but also his circuit.

Construction

To make the modification, you will need four wires about 24 inches long. Four different colors will help prevent wiring errors. If you have some four-wire cable on hand, that's even better. You will also need four pieces of heat-shrink tubing, 1/4 inch long and just large enough to fit over the individual wires, and one DPDT miniature switch.

Begin by removing the programming plugs from both drives. Configure them according to Figs. 1 and 2. If you have previously cut some of the straps, you can restore them by tack-soldering a small piece of hookup wire across the cut. Be careful while soldering on the programming plugs because the plastic will melt if you use too much heat.

On both plugs bend the rear pin of the DS1 strap up until it is parallel with the top of the plug. Do the same with the front pin of DS2 for the right plug and of DS3 for the left plug.

Cut the strap for DS3 of the right plug and the one for DS2 of the left plug. Also cut strap MX on both plugs. You may want to avoid making these cuts by simply bending a pin up so it no longer goes into the socket. If you do that, you will be able to easily restore the system later.

Now it is time to make a decision. You can drill a hole in the middle of the front panel to mount the switch or you can build a small bracket to hold it. The bracket can be attached to one of the screws that holds the top cover in place. The bracket idea is less convenient but allows you to restore the drive to new condition later.

If you decide to drill the hole, as I did, then you will want to be careful to mark the exact center of the drive midway between the top of the drive and the top of the cabinet (see Fig. 3). After you mark it with a pencil, double-check the position and then use a center punch to give the drill a sure starting place.

You should probably remove the drives before drilling the hole, but instead, I placed a rag behind the front panel to catch any aluminum shavings, which could cause serious problems if they got into the drives.

Start with a small drill and make a pilot hole at the punch mark. This pilot hole will make the larger hole easier to drill and, most important, will ensure that the hole will be exactly where you want it to be. This procedure will also keep the drill from slipping and scarring the front panel. After the pilot hole is made, select the correct drill size for the switch you have on hand and carefully enlarge the hole. Try the switch in the hole for proper fit, but do not mount it yet.

Use a four-conductor cable. If such cable is not available, you can form a cable by using your hand drill to twist the four wires

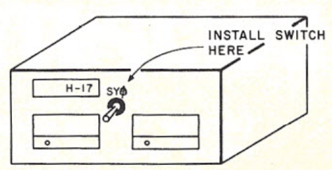

Fig. 3. Switch installation.

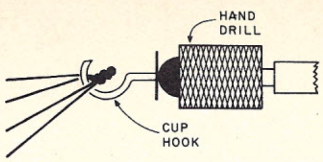

Fig. 4. Making four-conductor cable.

neatly together. Fig. 4 illustrates a method of attaching the wires to the drill. Clamp a small cup-hook into the jaws of the drill and knot the ends of the wires together. Hold the far ends of the wires in a vice, or clamp them in a drawer. Use the drill to twist the wires together, stopping just before the whole cable begins to knot up.

After forming the cable, unravel six inches of one end into two separate two-wire cables. Clip one of the two-wire cable sections to two inches from the point where the cable separates. Now strip each of the wires in the two-wire cables back about 1/4 inch and slip a piece of heat-shrink tubing over each wire. Solder the wires onto the pins of the programming plug as shown in Fig. 5.

The 2 inch cable section goes to the left plug. Slide the heat-shrink tubing over the connections and up against the body of the plug. Use a match or cigarette lighter to apply just enough heat to tighten up the tubing.

Now mount the programming plugs in their sockets on the drive. Dress the two-wire cables away from the plugs at right angles toward the center of the drive. When the cable reaches the center of the drive, dress it at a right angle down toward the bottom of the drive, then along the bottom toward the front and up behind the front panel to the position of the switch. Mark the cable, giving yourself a little extra length to work with, and cut it off.

The cable and programming plugs can now be removed from the drive, and the rest of the wiring can be done more conveniently on the workbench. Wire the switch as shown in Fig. 5.

When the switch is wired, place the cable, plugs and switch back into the drive and replace the plugs into their sockets. Mount the switch so the handle swings left and right. In this way, the position of the switch handle will indicate which drive is SYØ:.

Testing

Double-check to make sure you have removed the rag from inside the drive and that there are no aluminum shavings about, then turn everything on. Place a system disk into the left drive and place the switch in the left position. Make a normal boot.

If everything works the way it should, you're in good shape.

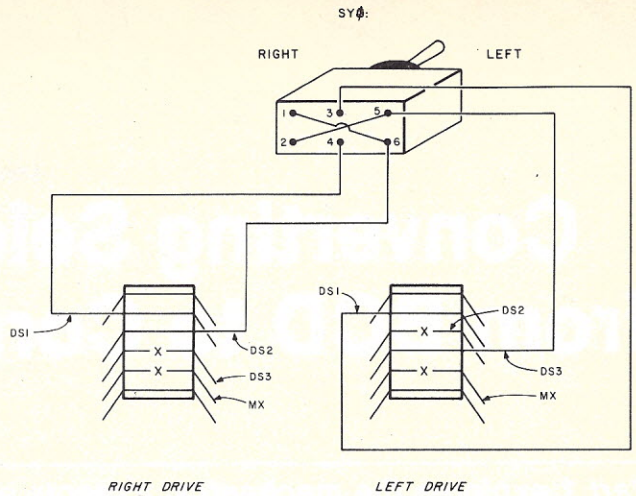

Fig. 5. Wiring.

Dismount SYØ: and move the disk to the right-hand drive. Throw the switch to the right-hand position and boot up again. If the system works the way it is supposed to, the modification is correctly installed. Replace the top cover and return to normal operation.

If the checkout procedure did not go according to the above paragraphs, you have probably made a mistake in the programming-plug configuration or have reversed the switch wiring. Reexamine the plugs, comparing them to Figs. 1 and 2. If they are correct, place the system disk in the left drive and place the switch in the right-hand position.

Attempt to boot up. If the system now works normally, then you have reversed wiring on the switch. Dismount SYØ: and change the wire at switch contact 5 to contact 1 and the wire at contact 6 to contact 2. Now go through the checkout procedures again. This time everything will work as advertised.

In addition to evening out the wear on the drives and helping when troubleshooting, the drive switch is convenient when "SYSGENing" a disk. Place the system disk in one drive and the disk to be "SYSGENed" in the other drive. Instead of continuously removing and reinserting the disks, now simply throw the switch back and forth in response to the prompts.■

Converting Selectric Keyboards from BCD to Correspondence Code

Part 1 explores the mechanical aspects of converting BCD Selectrics for computer use.

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Most small computer owners long for reasonably priced, high-quality hard copy. Matrix printouts on adding machine tape are fine for memory dumps, but it's hard to make a good impression with a 3-inch-wide letter. The need is particularly acute in my case. I am an attorney, and part of my rationale for having a personal computer was that it could be used in my practice for word processing, billing and repetitive typing tasks of all sorts.

Selecting a Selectric

There seem to be a lot of IBM Selectric I/O typewriters on the surplus market. Typically, they are Models 73, 731 and 735. The majority use BCD, rather than Correspondence, code. BCD machines come equipped with special uppercase-only typeballs, while office Selectrics and Correspondence-coded I/Os use uppercase and lowercase typeballs available in a wide variety of type styles. Several articles have been published telling how to use the more desirable Correspondence typeballs in a BCD-coded machine, but there are widespread misconceptions about what a BCD-coded Selectric I/O with a Correspondence typeball can and cannot do. It turns out that the BCD-coded machine has some very serious limitations, which this article will help you to overcome. Let me begin by explaining what those limitations are.

First, consider the printer portion of the machine. The printing process requires that the desired character be brought into printing position by simultaneous tilting and rotating of the typeball. The positioned typeball is then driven against the ribbon, printing the desired character. The amount of tilt and rotation is derived, by a mechanical code conversion process, from a six-bit (plus parity) code.

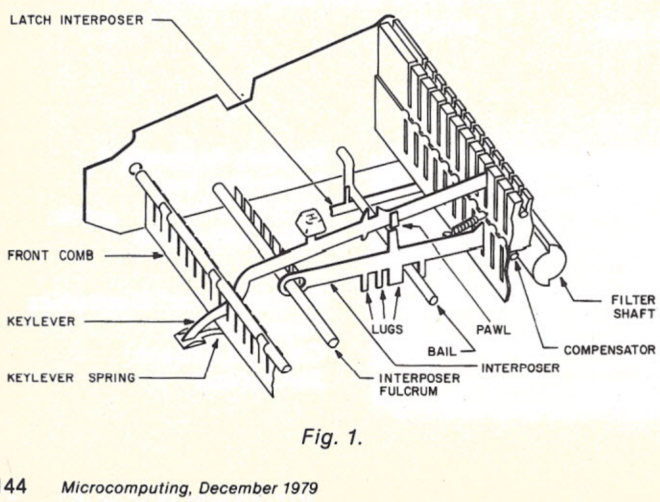

Fig. 1.

No matter whether a Selectric I/O is BCD coded or Correspondence coded, *a given six-bit code will always produce the same tilt and rotation.* This means that in order to print using Correspondence typeballs on a BCD machine, it is only necessary to feed Correspondence code to the six-bit inputs of the printer. Printing is the easy part.

Now let us consider the keyboard. When the BCD Selectric code was devised, IBM was operating within the constraints of a six-bit code, which permits 64 combinations. Certain punctuation and other characters, normally found in the uppercase, were deemed necessary to the character set. Codes for machine control functions, such as space, back space, tab, carrier return and index (line feed) were also required to fit within the 64 combinations. The resulting code required a special typeball, which eliminated lowercase and placed the characters in a different order on the typeball. The keyboard had to be modified to work with the special typeball, and the keyboard contacts had to be rewired. All of this was necessary so that a unique code in the six-bit BCD subset would be possible for each character and for each machine control function.

The result of this design approach is that the BCD keyboard, operating with a Correspondence typeball, types nonsense. Also, the keyboard puts out an electrical code that cannot include a full character set. This means that the user who elects to use a Correspondence typeball cannot use the BCD terminal as a typewriter, and that the keyboard cannot be used as an uppercase and lowercase input to the computer. In order to overcome these limitations and gain full use of a BCD Selectric terminal, it is necessary to modify the keyboard, both mechanically and electrically. This article describes how this is done.

Selectric Modification

Not long ago, I ran across a Model 73 at a local computer store at the friendly price of $375. I bought it. At the time, I was dimly aware of some of the problems with the BCD version. In order to understand them better, I decided to buy some reading material. I visited IBM's local office and bought Form No. 241-5737-0, a service manual; Form No. 241-5990-0, an adjustment and parts manual; and Form No. 241-5158-8, a parts price list. The whole works came to just $12.35. I rushed home and started reading. The service manual seemed most pertinent, so I started with that.

I can say without hesitation that I have never read a clearer, more explicit service manual. The unit is divided into subsystems. There is a lucid ex-

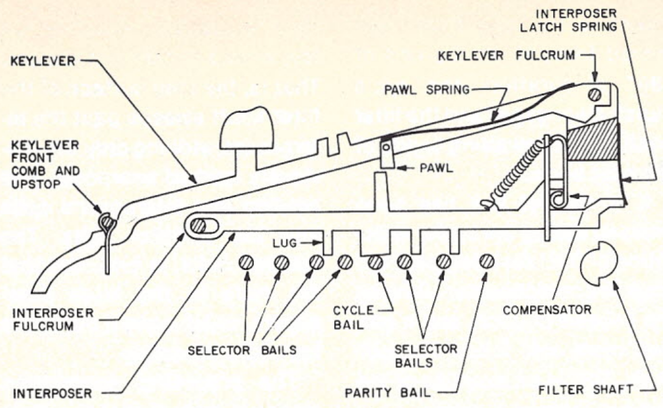

Fig. 2a.

planation of the theory of operation of each subsystem, followed by a detailed adjustment procedure for each component of the subsystem, arranged in an order that minimizes interaction of adjustments. The manual is so well done that the average hobby computer user with some mechanical aptitude should be able to perform his own routine maintenance and simple repairs.

My computer, like most, uses ASCII input and output code. My keyboard, however, does not generate a consistent uppercase code; there is some overlap between uppercase and control characters. I began to wonder how I could provide uppercase and lowercase input to the system. An obvious answer was to use the Selectric keyboard. Also, having invested a substantial amount of money in a keyboard printer, I wanted to use the device as a typewriter, off line, if possible. My reading disclosed that an unmodified BCD Selectric I/O could not be used for either purpose.

I called IBM service to ask what it would cost to convert my keyboard from BCD to Correspondence. The answer was "about $400." I decided then and there that either I could convert the machine myself or it didn't really need converting. I read the operational description of the keyboard and deduced that I needed to interchange some things called "interposers." In the back of the service manual, I found some instructions on how to remove an interposer. Armed with this information, I decided to attempt the modification. Obviously, I succeeded or this article wouldn't have been written. The task was a bit tedious, but not especially difficult once a few problems were overcome. I would like to share the things I learned with other Selectric I/O owners.

Selectric Keyboard Function

In order to understand what is involved, it is useful to consider what the Selectric keyboard does and how it does it. This entirely mechanical device performs the same functions as its electronic counterpart: It generates a binary code in response to a keypress, it stores the data in a latch, and it provides a strobe to tell the rest of the machine that data is available in the latch. Two-key rollover is provided to prevent generation of false codes when two or more keys are down, and to save the code from the second key until the first code is read out of the latch and printed. Now let's take a look at how these things are done without electronics.

The Selectric keyboard mechanism occupies the entire front half of the machine. Inside it, there are four layers of levers and rods, with springs attached here and there. The top layer consists of 44 *keylevers* (not including control keys), running fore and aft, pivoted at the rear of the keyboard. Fig. 1 shows the keyboard frame with one of the 44 keylevers in place.

The keybuttons are mounted directly on the keylevers. The second layer consists of 44 levers called *interposers*, pivoted at the front of the keyboard, and spring-loaded rearward and upward at the rear of the keyboard by 44 coil springs. The pivot is designed to permit the interposers to slide forward a short distance. When a key is pressed, a small pawl, projecting downward from its keylever, touches the interposer directly below it. The interposer is pushed downward until the keylever reaches the bottom of its stroke.

In order to describe what happens at this point, we need to take a look at some other parts that interact with the interposers. First, we will consider the latch mechanism. Fig. 2a shows that pressed against the rear surface of each interposer is a leaf spring, preloaded forward. These springs are called *interposer latch springs*; they are weaker than the coil springs mentioned earlier, so that at rest, the slack at the interposer pivots is taken up toward the rear.

As the interposer is pushed downward, just before the bottom of its stroke, its top edge moves past the bottom edge of the leaf spring, permitting the spring to snap forward. The bottom edge of the leaf spring then prevents upward motion of the interposer, latching it in the depressed position, as in Fig. 2b, even after its keylever is released. This is the latch function referred to earlier.

Note that encoding has not yet taken place. There are 44 interposers, so the latch holds data in one out of 44 locations, rather than in a more compact binary-encoded form, which would require only six locations to store up to 64 combinations. The manner in which the latch is reset will be covered later.

Let's now consider the mechanism which insures that only one out of 44 interposers can latch at a given time. Across the rear of the array of interposers, there is a metal tube. There are 44 saw slots cut partway through the tube. The slots are spaced to match the interposer spacing. The tip of a hookline projection on each interposer enters a slot when the interposer is depressed.

The tube is filled with ball bearings whose diameter equals the spacing between interposers. A threaded plug closes each end of the tube. The plugs are adjusted so that the space available within the tube is just equal to the sum of the diameters of all the ball bearings plus the thickness of one interposer. When an interposer is depressed, its tip enters the slot and displaces the ball bearings, taking up all the extra space in the tube. If a second interposer is depressed, it will encounter an immovable ball, which stops the interposer's motion near the top of its stroke.

Thus only one interposer can be latched at a time. This ball and tube arrangement, which IBM calls a *compensator*, also plays a part in the two-key rollover, which will be described later.

The third layer of the keyboard mechanism consists of eight metal rods with a cranklike offset at each end of each rod. These rods run from left to right, and their ends are fitted into simple bearings mounted on the left and right side plates of the keyboard assembly. Be-

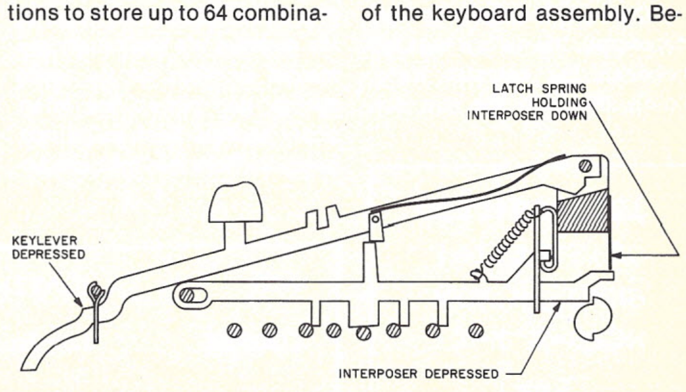

Fig. 2b.

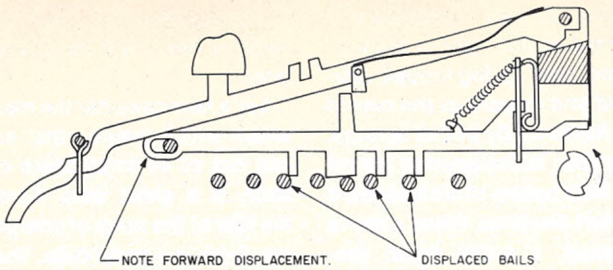

Fig. 2c.

cause of its shape, the center portion of each rod can move forward and backward, pivoting about the axis formed by its offset ends. A rod in the configuration is called a *bail.*

The fifth and eighth bails are bright metal, the other six are a gun-metal color. These six dark bails, each of which occupies either of two positions, define the six-bit binary keyboard output codes. These are called *selector bails.* Obviously, the encoding must take place between the second and third layers. Here is how it works.

Along the bottom edge of each interposer are projections called *lugs.* Every interposer has a wide lug at its center and at least one narrow lug at one of seven positions along its length. The pattern of the narrow lugs is unique for each interposer in a given machine. Each such pattern is the mechanical representation of the binary code for the character corresponding to that interposer. The absence of a lug in a given position is a "one" in that position; the presence of a lug is a "zero" (except for bit R5, which is inverted). The lugs impress this code directly on the bails in the following manner.

When an interposer is fully depressed, the narrow lugs fall between the selector bails, lightly touching the rear surfaces of the bails, as shown in Fig. 2b. The interposer's wide center lug presses downward on the fifth bail, which is called the *cycle bail.* Downward motion of the cycle bail engages the *cycle clutch,* which commences an encode-read-unlatch cycle. When the clutch is engaged, a shaft, which runs left to right behind and slightly below the interposers, begins to rotate.

This shaft, called a *filter shaft,* has a cam-shaped cross section, with an abrupt step each 180°. The position of the shaft is such that when it rotates, the step will strike the rear of any depressed interposer, driving the interposer forward. As the interposer moves forward, two things happen.

First, each of the narrow lugs on the depressed interposer pushes its corresponding bail forward. Thus, wherever there is a "zero" on the interposer, the corresponding bail moves forward; where there is a "one," the bail remains at rest.

Second, near the end of its forward motion, the interposer clears its latch spring, pushes aside its keylever pawl and is restored to its rest position. Fig. 2c shows the interposer at the moment the filter shaft has moved it clear of its latch spring, just before the interposer springs back to its rest position. Note that the bails adjacent to the lugs have been moved forward. At the end of 180° of rotation, the cycle clutch disengages and the filter shaft stops, awaiting input of the next code.

If a second key has been pressed during the cycle, restoration of the first interposer will clear the compensator allowing the second to latch, and a second cycle will follow immediately. This is an example of the two-key rollover function.

The fourth layer of the keyboard consists of the output connections. These take the form of seven *latch interposers* connected through links to the print mechanism in the rear half of the machine. The latch interposers are sliding members, spring-loaded toward the rear. Each latch interposer has one upward-pointing lug that rests against the front surface of a code bail. There is a latch interposer for each of the six code bails, plus one for the eighth bail, which provides a parity bit. A single latch interposer is shown in Fig. 1.

During the cycle described above, a forward motion is imparted to the particular bails corresponding to the character code. That forward motion is, in turn, imparted to the latch interposers and through them out of the keyboard.

Keyboard-Function Review

Reviewing the whole operation in electronic keyboard terms shows that the mechanism functions as follows: depressing a key moves a keylever downward, depressing the associated interposer and latching it. A lug on the interposer depresses the cycle bail. Depression of the cycle bail is a keypressed pulse that is delayed a few degrees of shaft rotation time to allow the interposer to reach the bottom of its stroke and latch, permitting the data to stabilize. After the delay, a read strobe is produced. That is, the step surface of the filter shaft sweeps past the interposers, striking only the previously latched interposer, and reading that interposer's code into the selector bails. The selector bails, in turn, conduct the code to the latch interposers, which carry it out of the keyboard assembly.

The preceding description makes it evident that the code generated by a particular keylever depends entirely on the configuration of lugs on its associated interposer. The task of code conversion, then, is simply the process of interchanging interposers. The next part of this article is a step-by-step description of how this is done.

Conversion

It is said that a few Selectric I/Os use other codes besides Correspondence and BCD. A simple way to find out whether your keyboard produces one of the standard codes is to borrow a Correspondence typeball, then see what it types in response to a given pattern of key depressions. Table 1 shows what my BCD Selectric typed with a Correspondence ball installed. It was produced by typing left to right on the top row of keys, then return, followed by the next row of keys and so on. If you get the same results, except for differences in punctuation or special symbols, your machine is BDC encoded.

A conversion table will be needed to show which interposer should be associated with which keylever. Table 1 could be used, but it is inconvenient because the interposers can most easily be removed and replaced in left to right order. Since only every fourth interposer is associated

```
123576840ZT9
OK;SULEYIA!
GNPQ,/M.VJW
HCFD=R'B-X
```

Table 1.

BCD	1QA2ZWS3XED4CRF5VTG6BYH7NUJ8MIK9ǂOL0.P$-/Θ⌑⁑
CORRES	log2hkn3c;p5fsq7du,6=1/8rem4'y.0bivz-ajtx½w9

Table 2.

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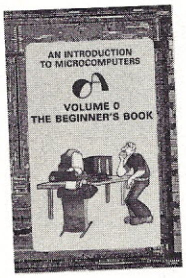

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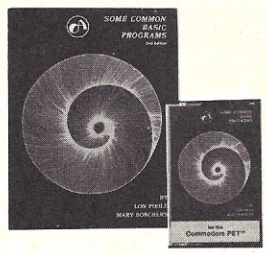

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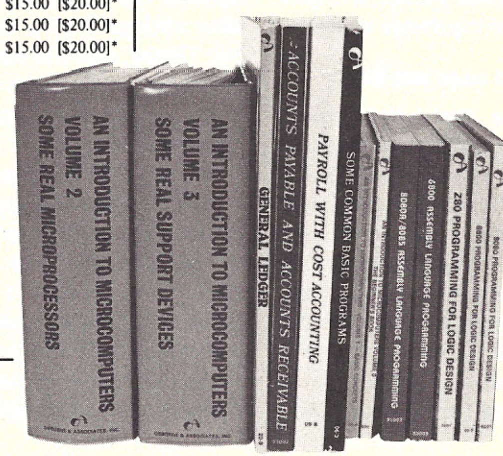

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with a particular row of keys, Table 1 would become hard to follow.

Table 2 was produced by depressing each keylever in turn, left to right, first with the BCD ball, then with the Correspondence ball installed. Note that no matter how your machine is encoded, this procedure will yield a table that will guide you through a code conversion.

In order to minimize the amount of thinking required during the conversion process, I went a step further and prepared Table 3 from the information in Table 2. Table 3 is intended to show, step by step, which interposers to leave alone, which to remove and which to replace them with.

The top row is the interposer position number. The second row indicates where the interposer to be installed in that position comes from. The circled numbers indicate that the interposer need not be removed because its position remains unchanged. The squares around some numbers indicate that they will have been removed from another position by the time you need them. Once you have developed your own version of Tables 2 and 3, it is time to start taking things apart.

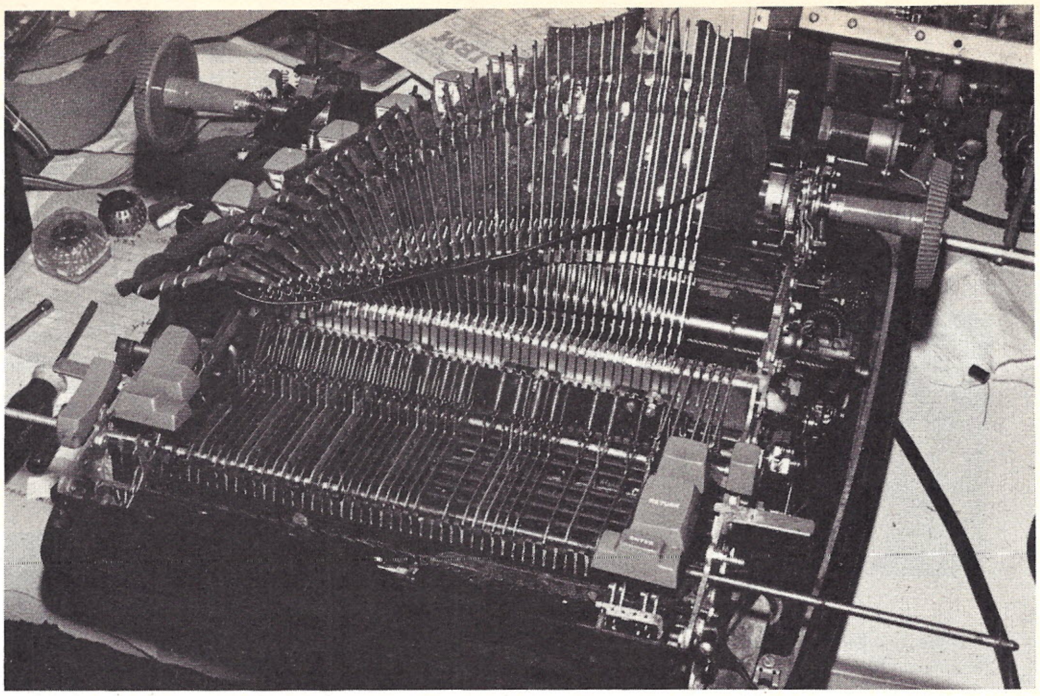

Photo 1.

Getting to Nuts and Bolts

First, a few words about tools and techniques. I used a pair of fine needle-nose pliers, a thin screwdriver, a medium screwdriver and two homemade spring hooks. The spring hooks were made by partially straightening two large paper clips. With the paper clips lying on a flat surface, a small notch was made across the wire about 1/16 inch from the straightened end, using a triangular file. The last 3/16 inch of one of the clips was bent at right angles, away from the notch. The other was left straight. The straight spring hook was useful for removing and replacing interposer springs; the bent hook helped replace the operational keylever springs during reassembly. Finally, you will need a 14 inch length of 3/16 inch steel or brass rod to act as a temporary interposer fulcrum.

You will find that the eye on the end of a tiny coil spring can be positioned quite accurately by slipping the end of the spring hook through it so that the notch catches the spring wire, then stretching the spring slightly. An inherent hazard in working with small springs is their tendency to fly across the room and disappear forever. To avoid this annoyance, take the following precautions: When removing or replacing one end of a spring, place a finger on the other end; add or release tension slowly with a spring hook; and try to avoid situations where a spring under tension is free to slide into a position where its tension will be released suddenly.

The precision sheet-metal parts you will be dealing with will tolerate a surprising amount of flexing without permanently bending. If, after studying the situation, you can see no way to move one such part past another without interference, try flexing one or both parts gently. To avoid permanent bending, flexing should not be concentrated at a sharp bend, but should be distributed along the full length of the part.

The first eleven steps will enable you to lift the 44 alphanumeric keylevers out of the way to gain access to the interposers. The remaining steps are the actual modification.

1. Begin by removing the cover. It is necessary to remove the platen before doing so, along with the paper deflector and the feed rollers.

2. Space or tab the carrier far to the right.

3. Observe the flat steel bar with gear teeth cut in its rear edge, running left to right near the rear of the keylevers. It is called the margin rack. Remove it as follows:

(a) Remove the screw near the right end, along with the hooked actuator and washer it holds.

(b) Loosen the nylon bearing at the right end, until the margin rack can be slid right far enough to clear the left side of the frame. Be careful not to lose the spring at the left end.

(c) Reassemble the actuator, the washer and the screw to the margin rack as a reminder of the way they should be assembled.

4. Remove the return spring and c-clip from the margin-release keylever; remove the keylever. The spring may be left hanging on its support.

5. Locate the bell-ringer bail, approximately one inch forward of the margin rack and parallel to it. Remove it as follows:

(a) Loosen the clamp at the left end, which holds the bell-ringer mechanism in place, and slide it off the end of the bail. Let it hang by its spring.

(b) Move the bail to the right

Position	1	2	3	4	5	6	7	8	9	10	11	12
Interposer	1	15	38	4	36	43	14	8	41	26	17	28
Position	13	14	15	16	17	18	19	20	21	22	23	24
Interposer	$\boxed{9}$	25	$\boxed{13}$	$\boxed{12}$	35	40	$\boxed{3}$	20	33	30	$\boxed{5}$	$\boxed{16}$
Position	25	26	27	28	29	30	31	32	33	34	35	36
Interposer	$\boxed{7}$	$\boxed{18}$	39	$\boxed{24}$	$\boxed{27}$	34	$\boxed{6}$	44	$\boxed{19}$	$\boxed{2}$	$\boxed{22}$	$\boxed{32}$
Position	37	38	39	40	41	42	43	44				
Interposer	$\boxed{31}$	$\boxed{11}$	$\boxed{10}$	$\boxed{37}$	$\boxed{23}$	42	$\boxed{29}$	$\boxed{21}$				

Table 3.

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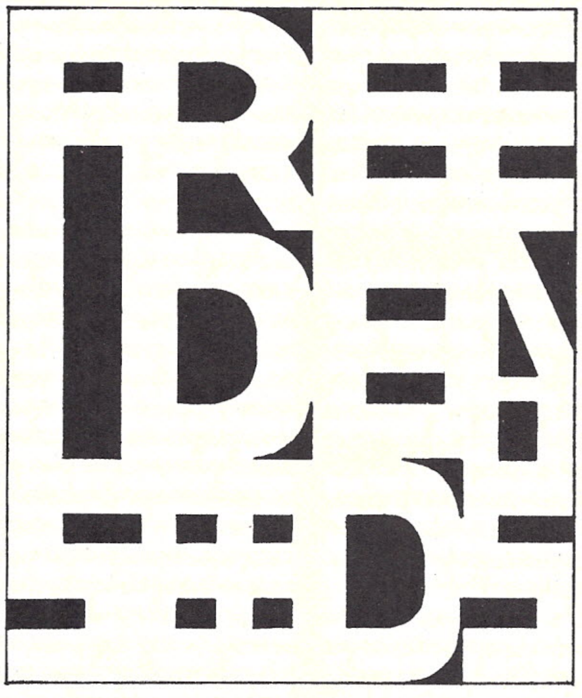

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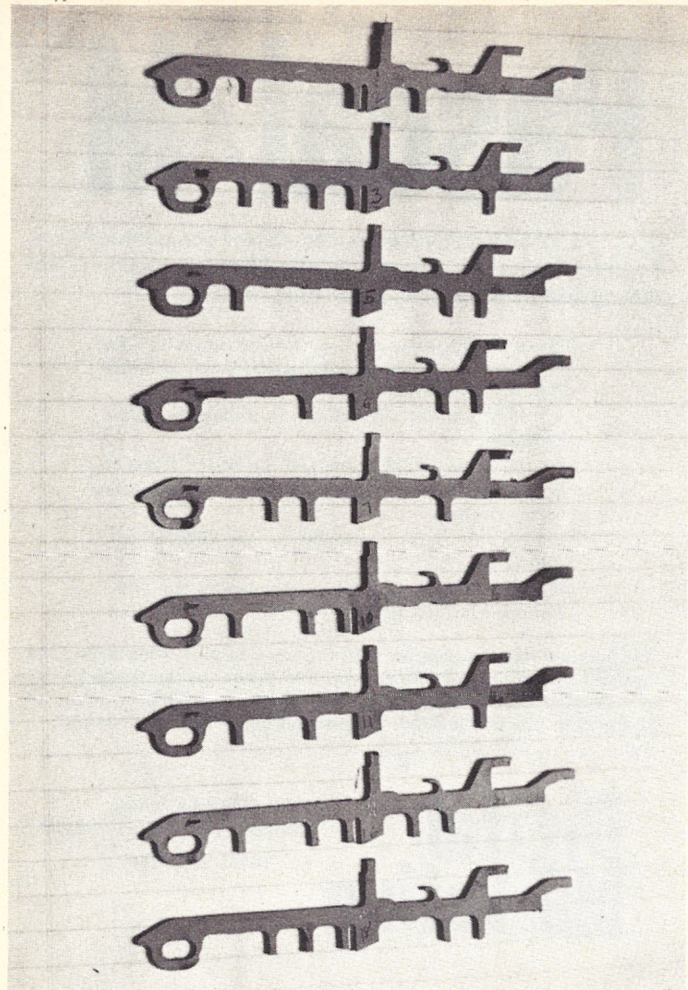

Photo 2.

until the right side disengages from the frame. Some units have a bar projecting forward from the bail and fitting between the first and second keylevers. If yours has this, move the bail carefully to the right while tilting it back so that the bar clears the keylevers.

6. Lift the foam acoustic material at the front corners of the keyboard. Locate the return springs for the machine control keylevers (tab, return, back space and shift). IBM calls these *operational* keylevers. There are six in all, two on the left and four on the right, at the front of the keyboard. Carefully disconnect them from the keylevers. This may be done by grasping the eye of each spring at the keylever with fine needle-nose pliers, stretching it just enough to clear the hook. Relieve the tension on the spring before releasing it. The springs may be left dangling from their brackets.

7. Examine the space bar. There are several versions, but each has a projection near the center of the bar which connects to some sort of link below the front edge of the keyboard. Its purpose is to keep the space bar from tipping forward, since it is hinged to its mounting shaft.

(a) Disconnect the linkage.

(b) Locate the space bar mounting shaft. Remove it, with the space bar, by loosening the bearing screw at its right end.

8. Locate the keylever upstop. The front ends of the keylevers pass through a *guide comb*, which looks just as you would expect. The tops of the comb teeth are formed to hold the upstop, a black rubber rod with a steel core. The upstop is removed by sliding it to the right until it is entirely free of the comb. There are holes in the sides of the frame directly opposite the ends of the upstop. The tab set and power switch levers cover these holes, but are provided with clearance holes to permit the upstop to pass through. On my machine, the clearance hole in the power switch lever didn't quite line up, so I removed the lever. As you slide out the upstop, each key will spring up a short distance when it is released.

9. Work the foam acoustic material over the operational keybuttons. Some tearing will probably occur, but with reasonable care the damage will be minimal. The material should be left under the alphanumeric keybuttons.

10. The next step is to pivot the keylevers up and back. This should be done more or less in unison, taking advantage of the foam tying the keylevers together. Take your time. Two types of resistance will be encountered:

(a) The front tips of the keylevers will catch on the tab bail and/or the shift bail, both of which are at the front edge of the keyboard. Gently snap the keylevers free, one by one.

(b) Keylevers at the left and right will encounter the operational keybuttons. I found it necessary to remove the left shift keybutton. Sufficient clearance for the other buttons may be obtained by gently flexing the keylever.

11. Support the keylevers in their raised position. I did this by attaching a clip lead at the rear of the platen area so that it hung across the underside of the keys. Refer to Photo 1.

12. Locate the interposer fulcrum rod. It runs through the front ends of the interposers and protrudes through the left and right sides of the frame. Remove the c-clip from the left end. You are now about to begin the interposer replacement process. Provide a surface on which you can place interposers after they are removed. You will probably need space for a maximum of twelve (12) interposers at a time. Photo 2 shows a group of interposers removed during my modification.

13. Insert the 3/16 inch rod through the fulcrum rod hole at the left of the keyboard, pushing the fulcrum rod toward the right ahead of it. Throughout this process, the 3/16 inch rod and the fulcrum rod should be moved in unison to assure that all interposers are held in place except the one you are working on. Note that according to Table 3, the first interposer need not be replaced. Push the fulcrum rod just to the right of the second interposer. Place your finger on the interposer coil spring. Using the spring hook, disconnect the spring at the interposer end and remove it. Notice that there are two colors of interposer springs. Brass springs alternate with bronze springs so that keybuttons in rows 1 and 2 require the same effort as those in rows 3 and 4. Be sure to install the springs in the same order as before they were removed. Withdraw the 3/16 inch rod just to the left of the second interposer. Now the interposer may be removed and set aside for later use. Write the number 2 on it to identify the position of origin. Note: The interposers will be stamped with numbers, some of which may be correct. On my unit, fewer than half were correct, so I concluded that it is unwise to rely upon them.

14. Push the fulcrum rod to the fifteenth position and remove the interposer. Push the fulcrum back to the second in-

```
1qa2zws3xed4crf5vtg6byh7nuj8mik9,ol0.p;-/½'=
```

Table 4.

terposer position and insert the interposer from position 15. When you install an interposer, the best method is to insert it at a shallow angle into the rear comb. If you encounter resistance, gently wagging the interposer up and down should permit it to slide to the rear. Now attempt to lower the front of the interposer. If resistance is encountered, check to see if a lug is caught on a bail. If it is, move the bail forward slightly and the interposer will slip into place. Immediately slip the fulcrum rod through it and replace the spring.

15. Following Table 3, remove and replace interposers and their springs in a left-to-right order until all 44 have been placed in the new positions. Mark all removed interposers and reinstall them as their numbers come up in Table 3.

16. Loosen the wire supporting the keylevers, allowing them to move clear of the path of the typeball carrier.

17. Reinstall the feed rollers, paper deflector and platen. Install a Correspondence typeball, insert a piece of paper and test the keyboard by depressing the interposers, one by one, from left to right. The characters should appear in the order shown in Table 4. If there is a discrepancy, a careful comparison of your printout with Table 4 will reveal which interposers are in the wrong locations and where they belong.

18. After making any necessary corrections, push the 3/16 inch rod out of the keyboard with the fulcrum rod. Reassemble, in reverse order, the items disassembled in Steps 3 through 12.

You have now completed the mechanical part of the modification. At this point, it is possible that the margin mechanism may need adjustment. To check it, insert a piece of paper. Tab to the extreme right, then press the carrier return. Type one character, then press carrier return again. Type the same character. If the characters are not in the same column, the margin mechanism needs adjustment. The position of the actuator on the right of the margin rack should be adjusted so the return from the right ends at the same place as a return from the second column. Once this is properly adjusted, the terminal will function as a typewriter, using Correspondence typeballs.

Preview

Part 2 of this article will provide step-by-step instructions for rewiring the BCD Selectric I/O to correspondence code, including "before" and "after" schematics, along with some suggestions for interfacing with ASCII inputs and outputs.■

Reader Service—see page 227

Extending the Altair Bus

This bus expansion article solves the problem of running out of space on the parent mainframe. It shows how the signal waveform may vary along seemingly low-resistance leads.

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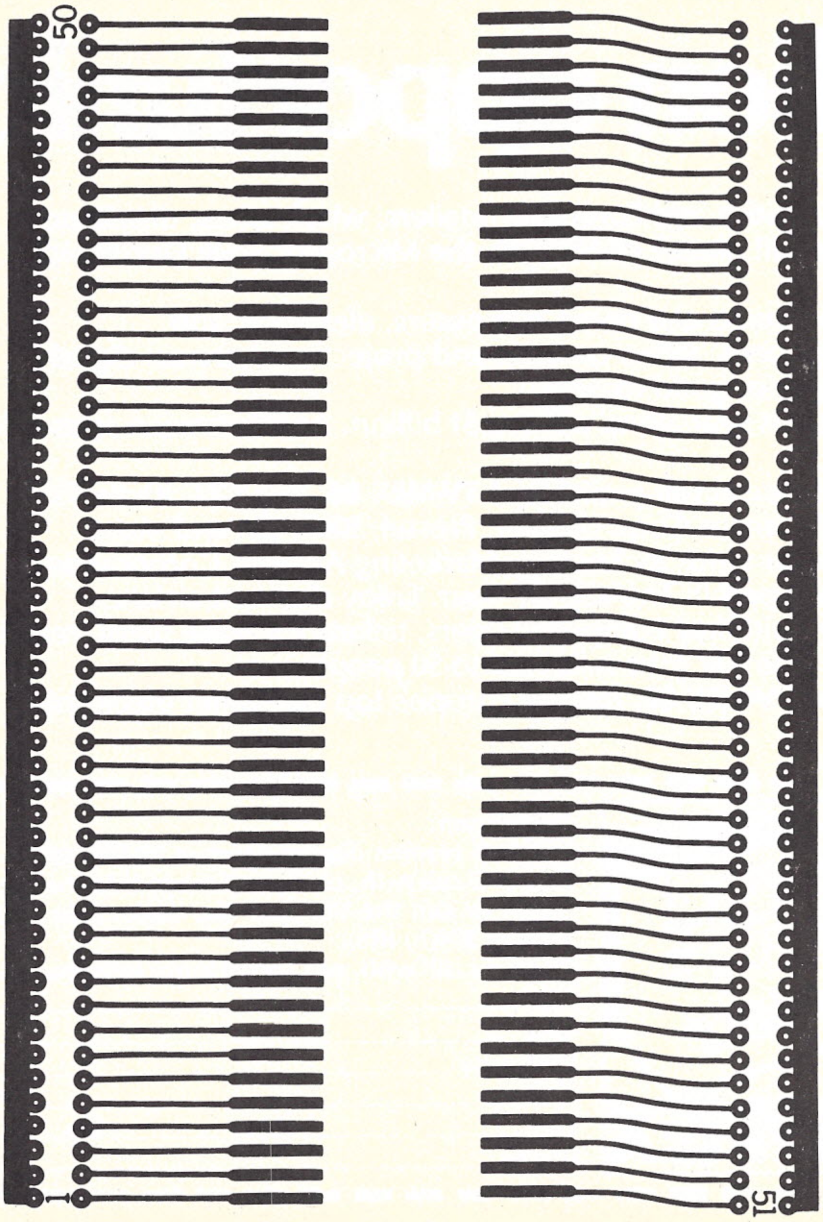

The S-100 (Altair) bus has become very popular over the past three years, and a great many exciting and mutually compatible boards are offered by several manufacturers. For some of us, this electronics heaven has led to a lack of sufficient space and power to accommodate a heavy complement of boards.

My Altair was one of the early models that consisted of four small motherboards, each containing four slots. It originally came with an inadequate power supply that was later upgraded to a model "a." Thirteen of the 16 slots are presently occupied, and the power supply is straining under the load.

Fig. 1. Foil pattern layouts for an S-100 bus to ribbon cable connector. Observe that provisions for interleaved ground wires are provided. Full size film negatives for etching these patterns are available for personal use from the author for $3 per set.

To directly add my seven extra S.D. Sales 4K static memory cards (current-hungry 2102s), I would have had to pull boards that made the computer particularly interesting: a Cromemco Dazzler (color graphics/two slots); a Processor Technology VDM-1 (video monitor/one slot) and a Mits 88-ACR (cassette interface/two cards, one slot). Also, I would have had to rebuild the power supply.

Trading I/O capability for memory was not a particularly appealing alternative, especially since my 88-ACR may be one of the few that is operating reliably (at last). I didn't dare touch it. Also, changing the power supply would have ruined the antique value of the old Altair. I therefore decided to extend the bus to a second motherboard having its own power supply.

At one time Mits offered just such a remedy. They called it an "expansion cabinet." Apparently it was never manufactured and soon disappeared from their product list, probably due to a lack of demand (the price was high). More recently, several manufacturers have advertised mainframe building blocks for do-it-yourself computerists. These include cabinets consisting of just a motherboard and a power supply. The remaining problem is to connect the main computer bus to the bus in the expansion cabinet.

The solution to the connection problem at first appears obvious: run wires between the motherboards. However, with my limited background in radio communication, I recognized that transmitting broadcast band (megacycle, or these days, megahertz) signals over parallel lengths of wire was an invitation to crosstalk trouble, reflections and other Murphy's Law effects. Seeking technical help at computer stores led to a variety of responses, including:

"You'll ------ the signals." (Thanks.)

"Keep the wires short." (Three inches does not go far.)

"Just terminate the line right." (What is right?)

"We have a special on 16K boards." (Want to trade?)

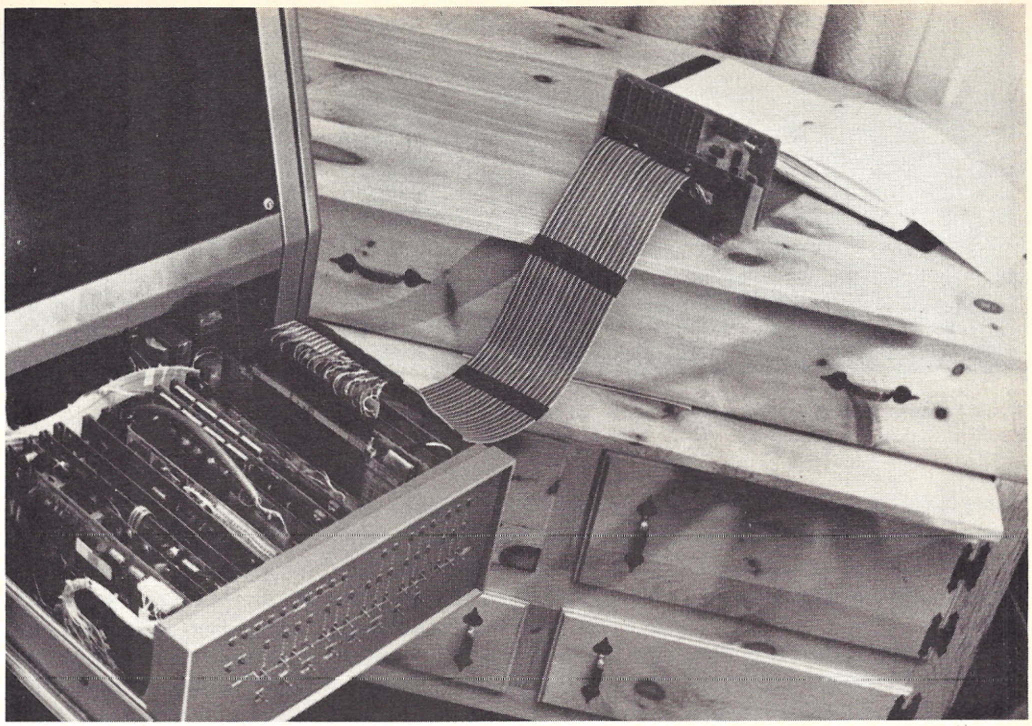

Fig. 2. The test setup with the ribbon cable running from an extender card plugged into the Altair motherboard to a second motherboard.

"I don't know." (At least that is honest.)

With a dearth of information at hand, I chose to run ribbon cable between the motherboards and use a Godbout Active Terminator card at the far end of the cable. Curiously, this solution worked. However, as we will see, the bus signals were clearly injured in the process.

The Four-Foot Connection

Running close to 100 signal wires between two motherboards requires some planning, coordination and patience. Since it was not desirable to hard-wire into one of the four-slot Altair motherboards, I laid out simple foil pattern S-100 edge connectors (see Fig. 1). Provisions were made to use ribbon cable with every other wire being a ground. Thus, a 200-wire ribbon-cable shielded configuration resulted.

Even though I never tried an unshielded cable, it probably would not work very well. The alternate ground wires significantly reduce crosstalk and constitute a common approach to multiple wire signal transmission.

In the form constructed, the wires were 24 gauge with a cable length of four feet. See Fig. 2. For the first expansion test, the cable was also used to bring power to the second motherboard. This is generally not good procedure, but was acceptable for "wringing out." Note that the cable resistance was about 0.1 Ohms per wire. The ground connection consisted of 100 wires (0.0001 Ohms; the S-100 connector contact resistance is certainly more than this).

The "unregulated" 8 volt power was carried by two wires, giving a 0.05 Ohm cable resistance. Less than two Amps (dc) were carried over the cable during the final test. The regulator and filters on the S.D. Sales memory card can counter this voltage drop, and 2102 memory chips are very tolerant.

Once the cable was built and carefully checked for continuity and shorts with a volt-ohm meter, I plugged it into the Altair bus. With some hesitancy, I turned the Altair on . . . no smoke.

Bus Waveforms

The greatest source of concern was not a wiring error, but rather what effect the cable would have on the shape of the signals propagating down the bus. To test this, I borrowed a good oscilloscope and probe from work and made a systematic check of bus waveforms. See Table 1 and Photos 1 through 15. Two particular signals were monitored: PSYNC and Ø1.

PSYNC is an output from the CPU board which signifies that the information on the data bus contains processor status information. It occurs once at the beginning of every machine cycle. The PSYNC waveforms obtained were for a tight self-jump loop. They appear on the photographs spaced (center to center) 1.5 microseconds apart. A machine-language loop was required to give a stable triggered display on the oscilloscope. PSYNC does not appear if the computer is not running (e.g., waiting).

Ø1 is one phase of the two-phase system clock. These clock pulses repeat every 0.5 microseconds.

Photo 1 shows the parent of PSYNC—SYNC. The latter signal comes directly out of the 8080 CPU chip. It is well formed and contains very little noise. SYNC goes into an 8T97 Tri-

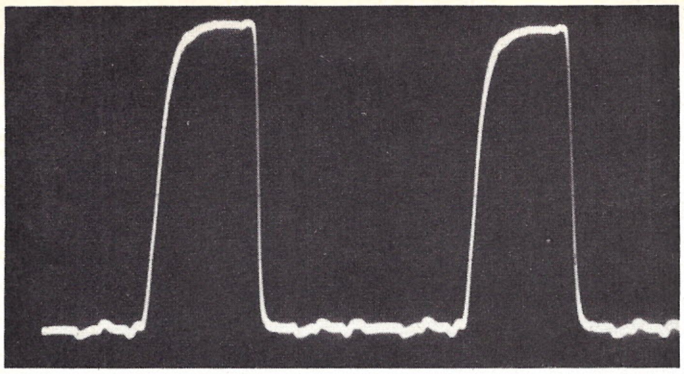

Photo 1. 1C5, pin 2, without cable, without Godbout.

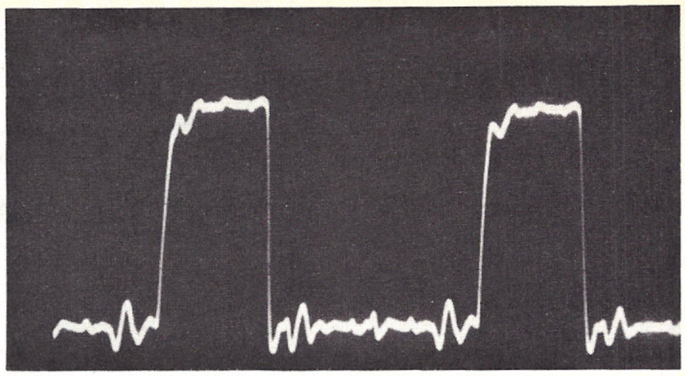

Photo 3. PSYNC on extender card, without Godbout, without cable.

state gate (ICJ, pin 2) and comes out as PSYNC (ICJ, pin 3). This signal in turn goes directly to the bus (motherboard traces).

Photo 2 shows PSYNC at the CPU board connector (pin 76) under normal conditions. PSYNC appears to have a logic voltage level lower than SYNC; the 8080 CPU chip logic levels are generally higher than the TTL standard. The waveform appears reasonably clean.

To follow the propagation of signals down the bus, I placed an extender card in slot #13 (CPU board in slot #1). At this position PSYNC looks as shown in Photo 3. Observe that some well-determined glitches have been picked up along the bus. The glitch level is about 0.8 volts peak to peak, with a period of approximately 100 nanoseconds. Photo 4 shows Ø1 (pin 25) at the same slot. It contains similar disturbances.

With the cable inserted on the extender board, the waveforms are quite different. Photo 5 shows the PSYNC signal at its origin—ICJ, pin 3. A significant amount of noise has made it down the bus and up the traces to this generation point.

The situation at the extender card (Photos 6 and 7) is much worse. However, the computer continued to operate flawlessly even under these adverse waveform conditions; the glitches do not exceed the logic transition levels.

Checking the unconnected end of the cable we also see significant disturbances in the waveforms. The glitches imposed on PSYNC (Photo 8) appear to be similar to those seen at the extender card, though they are generally larger. However, the form of the glitches superposed on Ø1 at the end of the cable is somewhat different from the form of those observed at the extender card. With a little imagination you can visualize that some other glitches have been added onto those that were apparent at the extender card to give the results seen at the end of the cable. These new disturbances appear to have a period of between 50 and 100 nanoseconds.

The intellectual question immediately arises as to where these disturbances come from. If the source were crosstalk,

Configuration	8080 CPU SYNC	PSYNC at BUS beginning (J3)	PSYNC at Extender Board (76)	Ø1 Extender Board (25)	PSYNC at End of Cable (76)	Ø1 at End of Cable (25)	PSYNC on Second BUS Board (76)	Ø1 on Second BUS Board (25)
No Cable No Terminator	Photo 1	Photo 2	Photo 3	Photo 4				
Cable No Terminator		Photo 5	Photo 6	Photo 7	Photo 8	Photo 9		
Cable Godbout Terminator		Photo 10		Photo 11	Photo 12	Photo 13		
Cable Godbout Terminator on Second Bus board						Photo 14	Photo 15	

Table 1. Measurement points.

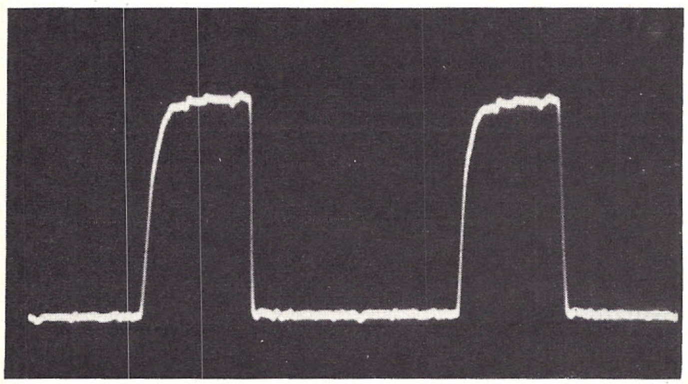

Photo 2. ICJ, pin 3, without cable, without Godbout.

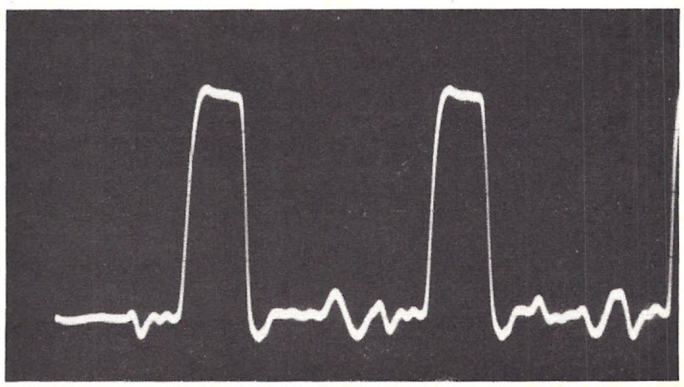

Photo 4. Ø1 on extender card, without cable, without Godbout.

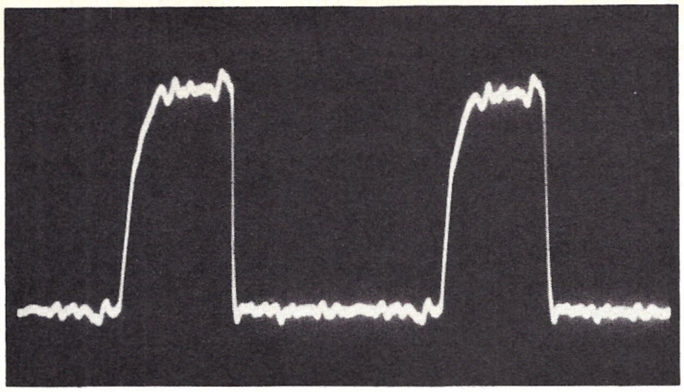

Photo 5. IC5, pin 3, with cable, without Godbout.

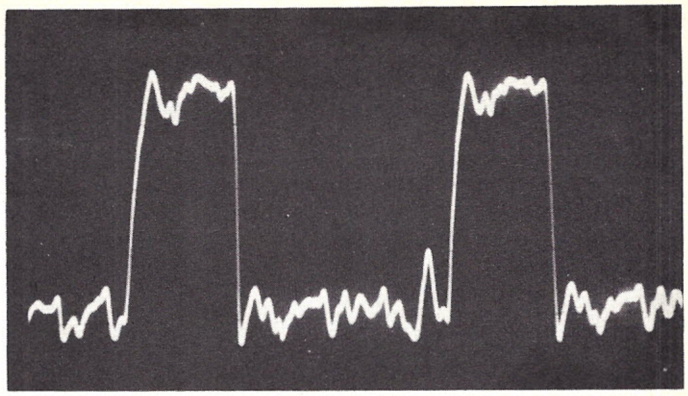

Photo 6. PSYNC on extender card, with card, without Godbout.

then the period should be related to the transition time between states on some neighboring line (note, dc levels on neighboring lines do not impress disturbing signals). Fifty nanoseconds is not an unreasonable value for such transitions, especially considering that there is a large capacitive load on this particular bus.

If the source of the glitches were reflections, then you might guess that the associated wavelength should be roughly twice the entire bus length, roughly 10 feet. At the speed of light this amounts to a period of about 20 nanoseconds. Some of the low-amplitude noise apparent on Photo 8 might be due to such reflections.

To reduce crosstalk you can lower the impedance of the bus such that unwanted induced currents lead to smaller voltage excursions. A resistive terminator can be used to accomplish this.

To diminish reflections, the bus should be terminated with a matching load equal to the characteristic impedance of the line. Unless the match is within a factor of two of the correct value, the reflections will not be greatly reduced. Reflections, if they exist, are difficult to "tune out."

The apparent effect of the Godbout Active Terminator is to place a resistive load on the line and thus reduce the influence of induced current spikes.

A Terminated Bus

To accomplish the bus termination referred to above I used a Godbout Active Terminator (see Fig. 3). This device terminates each of the 94 possible signal lines of the S-100 bus with a 270 Ohm resistor connected to a 2.6 volt voltage source. Its effect on PSYNC at the CPU card may be seen by comparing Photo 10 with Photo 5. The noise is quite measurably reduced, along with a small loss in the logic level due to the increased loading.

The effect on Ø1 at the extender card is also visible (see Photos 7 and 11). Similar improvements are evident in the PSYNC and Ø1 waveforms at

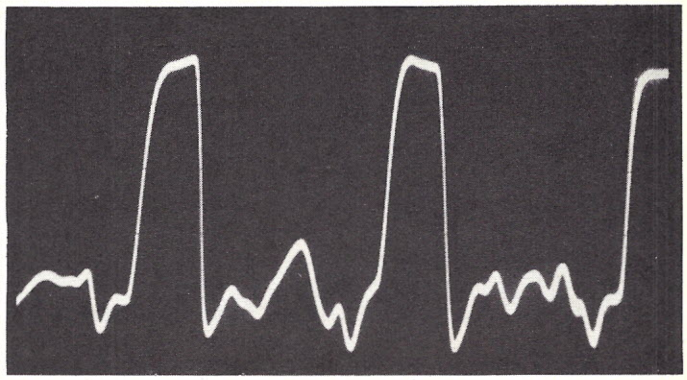

Photo 7. Ø1 at extender card, with cable, without Godbout.

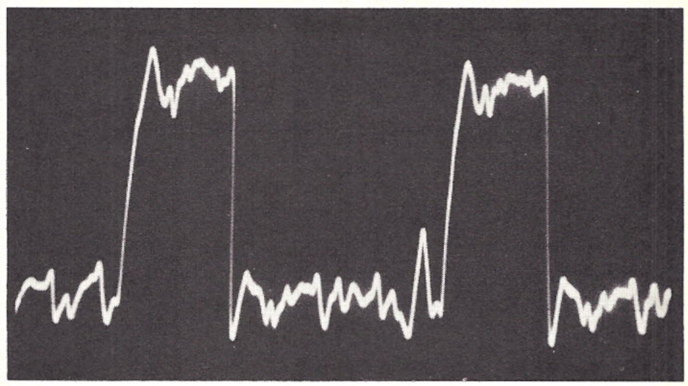

Photo 8. PSYNC at cable end, with second motherboard with Godbout in next slot.

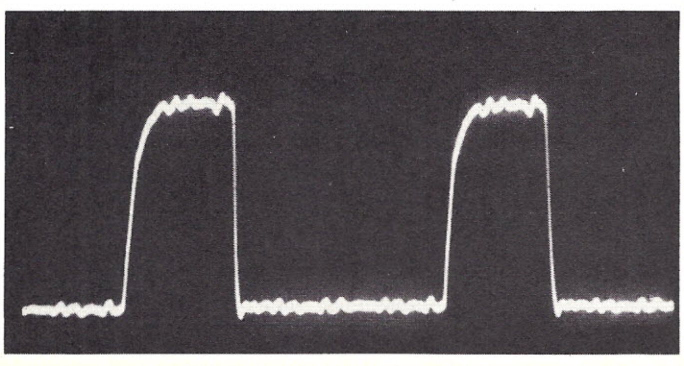

Photo 10. 1CJ, pin 3, with cable, with Godbout, without second motherboard.

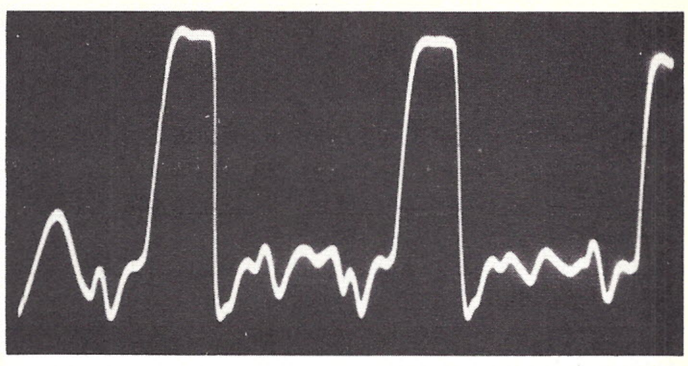

Photo 9. Ø1 at cable end, without Godbout, without second motherboard.

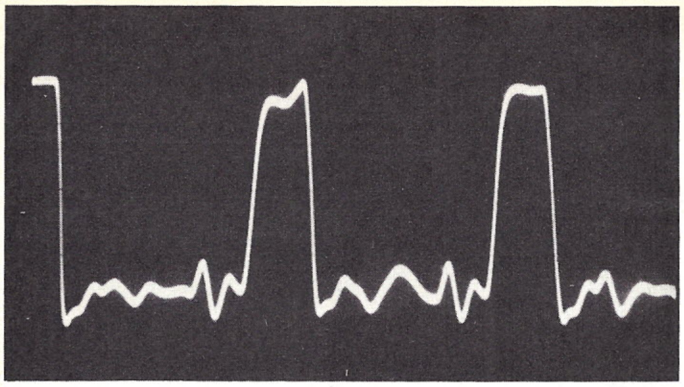

Photo 11. Ø1 at extender card, with cable, with Godbout.

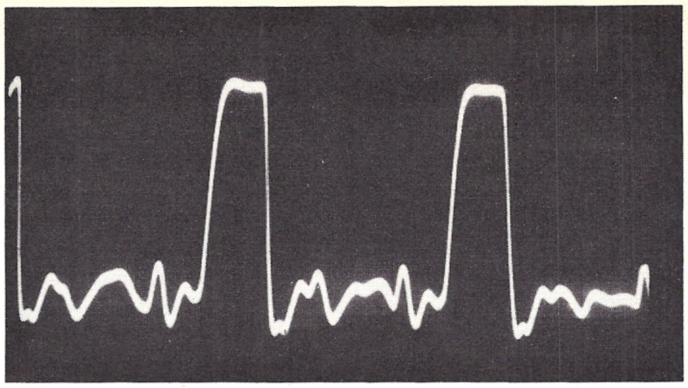

Photo 13. Ø1 at cable end, with Godbout.

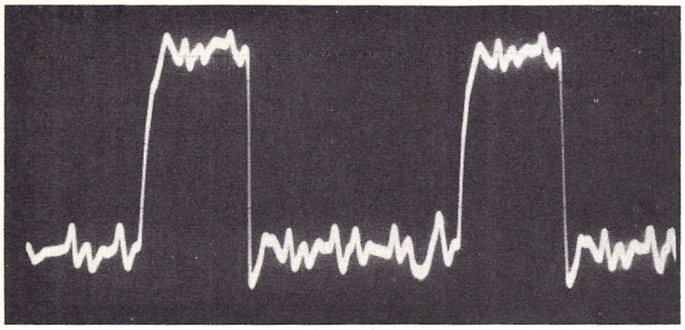

Photo 12. PSYNC on cable end, with Godbout, without second motherboard.

the end of the cable.

The final addition to the extended bus was the second motherboard. The one chosen was a twelve-slot Godbout creation. This board has the nice feature of containing provisions for the same active termination circuitry that appears on the separate board shown in Fig. 3. I plan to use this when the second motherboard is fully outfitted with its own cabinet and power supply.

With the configuration shown in Fig. 2 (active terminator and 4K static memory board inserted in the second motherboard), the signals shown on Photos 14 and 15 were obtained. They appear to be slightly better than those seen on Photos 12 and 13.

Under these conditions the memory card on the second motherboard operated without error during an overnight memory test. Removing the active terminator did not affect this result, though the margin of safety is certainly less without the terminator.

Summary and Conclusion

This article has shown that extending the bus of an Altair 8800A is reasonably easy. The Altair bus driver electronics are not so unique that the technique discussed should not be feasible on other S-100 bus computers.

The resulting waveforms show signs of being significantly disturbed by the four-foot extension cable. The source of the noise is probably crosstalk. However, the effect is not large enough to cause failure. Using a Godbout Active Terminator measurably reduces the crosstalk problem, though it also depresses the logic levels slightly. Although the effects of not having alternate wire grounds in the ribbon cable were not examined, they probably would have been severe.

In conclusion, the approach to bus expansion discussed in this article presents a solution to the problem of running out of space in the parent mainframe. It is also an interesting example of how the signal waveform may vary along seemingly low-resistance bus leads. ■

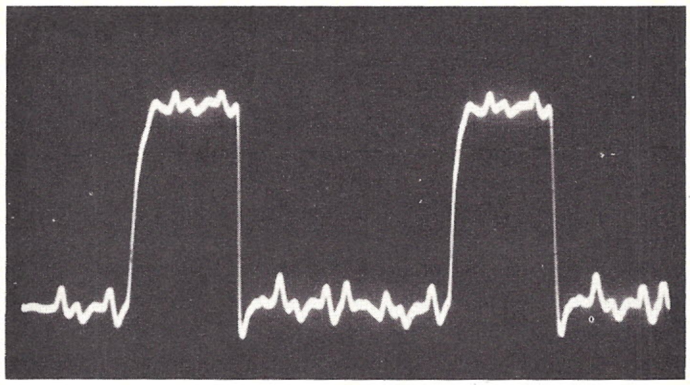

Photo 14. PSYNC at connector on second motherboard, with Godbout in next slot.

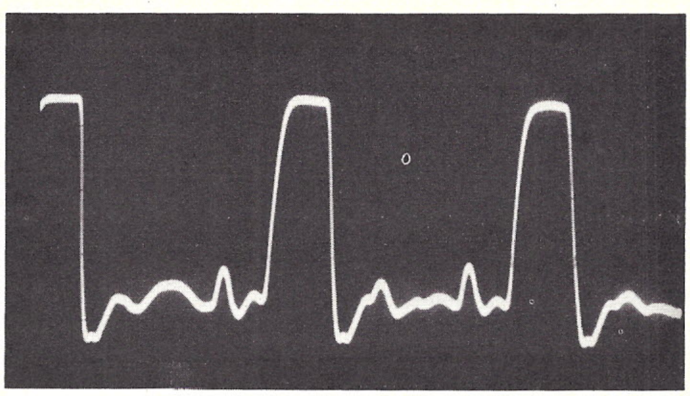

Photo 15. Ø1 at cable end, with second motherboard, with Godbout in next slot.

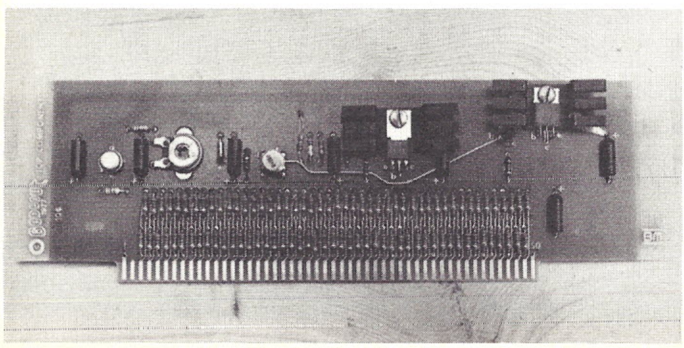

Fig. 3. The Godbout Active Terminator.

✓ *Reader Service—see page 227*

H8 Alarm Clock Program

It's H8 o'clock: time to read this article.

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Are you beginning to feel a little guilty about all of the money you have soaked into the micro, which sits unused most of the day? Star Trek no longer rationalizes your purchasing the machine. It's high time you gave it a functional purpose. It doesn't have to be a terribly important function, just something to help justify its existence.

How about a digital clock for the living room or an alarm clock for the bedroom? If you have none of the above guilt feelings, how would you like to own the most expensive clock on the block (and possibly in the city)?

With its nine-digit LED display and internal speaker, the Heathkit H8 is a natural as an alarm clock. Although the following program is written for the H8, with modification the program can be applied to other microcomputers. The LED display and speaker are not necessary for useful application of the basic timekeeping routine.

The Timer

The program keeps time by referencing the two-byte internal clock tick counter. This counter is incremented once every two milliseconds. For accurate timing, only the high-order byte of the counter needs to be referenced via PEEK. This one-byte counter is incremented by overflow from the low-order byte every 512 milliseconds and therefore causes a 3/125-second error per second when being converted to seconds. This error is corrected every 125 pseudo-seconds in line 420 and is unnoticeable in operation.

Referencing the internal counter, as opposed to an in-line PAUSE, allows a variable amount of code to be executed without affecting the timing cycle. However, if you add further applications to the code, the cycle must execute within 512 milliseconds, or the clock will run erratically and may even stop.

```
RUN
DO YOU WISH TO SET THE ALARM ?  YES
IS ALARM BEING SET FOR 'AM' OR 'PM' ?  AM
ENTER ALARM TIME AS 4 DIGITS:  HHMM  0630

DO YOU WANT AUDIBLE TICK-TOCK ?  YES

IS CURRENT TIME OF DAY 'AM' OR 'PM' ?  PM
ENTER CURRENT TIME AS 6 DIGITS: HHMMSS  103735
```

Sample run. At this point, the LED display begins incrementing the seconds from 10 37 35. Each time the display is incremented, there will be an audible tick sound. The terminal can now be turned off. The alarm will sound at 6:30 AM.

The Display

The H8 LED display is physically arranged in three groups of three LED digits. Their purpose is to display three octal bytes. However, it is also a convenient arrangement for displaying HOURS-MINUTES-SECONDS.

The high-order digit of each three-digit group is turned off in line 340. The two low-order digits of each group are used for their respective time displays and are reset every 1024 milliseconds in lines 480-500. The purpose of the SEG function used in the display control lines is to convert the decimal digits into control codes that cause the appropriate display segments to be lighted.

The Alarm

The H8 contains a speaker that can be activated by a bit flag in a low-core control byte. The current control byte is preserved, and a corresponding alarm-on control byte is created in line 330.

Line 560 is a subroutine that POKEs the alarm-on control byte, PAUSEs a variable time (short for tick-tock, long for alarm) and then turns the alarm off by POKEing the original control flags back into the control byte. The result is a tick sound for the tick-tock effect or a short beep for the alarm, each triggered once per second.

To turn the alarm off, enter CTL-B on the terminal. The CTL-B vector, which is initialized in line 320, causes an immediate GOSUB to line 550. The alarm is turned off, and the clock continues cycling. Twenty-four hours later, without resetting, the alarm will go off again.

The catch—if you didn't notice—is that the terminal must be on in order to turn the alarm off. This means you must either leave the terminal on or take the extra time to turn it on when deactivating the alarm.

Alternatives would be to let the program turn the alarm off after a given number of seconds or enter the CTL-B signal through an auxiliary port. To impress your friends, though, the CTL-B technique is much more effective. They will be so appalled at the extravagance of the scene that they won't even think of the impracticality of the CTL-B.

Going Further

The alarm, of course, is not the ultimate in practicality. Its purpose is served by showing how to use the timing routine to activate and deactivate.

Instead of turning an alarm on and off, you can strobe an output port to turn anything on and off at any particular time, AM or PM: warm the coffee at 6:30 AM, turn the house lights on at 6:45 AM, phone you in sick at 7:15 AM, turn on the TV at 7:17 AM, etc.

Setting the Clock

You are first prompted to set the alarm. If you wish to set it, you are then asked for the alarm time in HOURS-MINUTES and which 12-hour segment of the day you are referring to (AM or PM).

Next you are asked if you want the simulated tick-tock ef-

fect. If yes, the program produces a tick-like sound through the internal speaker each time the display is updated.

Next you set the clock itself to the current time as HOURS-MINUTES-SECONDS and AM/PM. There will be a small program and display initialization delay after you hit the carriage return (allow for it if the seconds are important to you). Then you are free to shut the terminal down and watch the seconds tick away.

Additional Comments

The program as written will run under both Heathkit Extended Cassette and Disk BASICs. However, it would be better to load this program via cassette since it is not recommended to shut the disk down without dismounting the diskettes.

If you do not have an H8, you can still use the timekeeping routine as long as your micro has an internal clock counter that can be accessed. The program relies on a two-byte counter that increments every two milliseconds. If your counter increments at a different frequency, it will be necessary to tune the cycle hold routine (lines 390, 400, 430) and/or the error adjustment routine (line 420) to operate at your frequency. ■

```
00010 REM          <<<<< ALARM CLOCK >>>>>
00020 REM
00030 REM      << WRITTEN BY ADRIAN THORNTON >>
00040 REM
00050 REM          * SET ALARM IF DESIRED *
00060 REM
00070 LINE INPUT "DO YOU WISH TO SET THE ALARM ?  ·";X$
00080 IF LEFT$(X$,1)="N" THEN A$="0000":GOTO 140
00090 LINE INPUT "IS ALARM BEING SET FOR 'AM' OR 'PM' ?  ";X$
00100 S1=1:IF X$="PM" THEN S1=-S1
00110 LINE INPUT "ENTER ALARM TIME AS 4 DIGITS:  HHMM  ";A$
00120 IF LEN(A$)=4 AND VAL(A$)<=1259 AND VAL(A$)>=100 THEN 140
00130 PRINT "INVALID TIME ENTRY"GOTO 110
00140 A1=VAL(LEFT$(A$,2)):A2=VAL(RIGHT$(A$,2))
00150 REM
00160 REM          * SET AUDIBLE TICK-TOCK *
00170 REM
00180 PRINT :LINE INPUT "DO YOU WANT AUDIBLE TICK-TOCK ?  ";Z$
00190 Z$=LEFT$(Z$,1)
00200 REM
00210 REM          * SET CURRENT TIME *
00220 REM
00230 PRINT :LINE INPUT "IS CURRENT TIME OF DAY 'AM' OR 'PM' ?  ";X$
00240 S2=1:IF X$="PM" THEN S2=-S2
00250 LINE INPUT "ENTER CURRENT TIME AS 6 DIGITS: HHMMSS  ";T$
00260 IF LEN(T$)=6 AND VAL(T$)<=125959 AND VAL(T$)>=10000 THEN GOTO 280
00270 PRINT "INVALID TIME ENTRY":GOTO 250
00280 T1=VAL(LEFT$(T$,2)):T2=VAL(MID$(T$,3,2)):T3=VAL(RIGHT$(T$,2))
00290 REM
00300 REM          * SET UP DISPLAY AND INITIALIZE CONSTANTS *
00310 REM
00320 CNTRL 2,1:CNTRL 0,550:REM TURN ON DISPLAY AND SET CTL-B VECTOR
00330 Z2=PEEK(8201):Z1=Z2 AND 127:REM SET ALARM ON/RESET CTL CODES
00340 FOR I=0 TO 2:POKE 8203+I*3,255:NEXT I:REM SET HIGH DIGITS TO BLANKS
00350 A=0:B=250:D=1
00360 REM
00370 REM          * TIME KEEPING ROUTINE *
00380 REM
00390 X=PEEK(8220):REM LOOK AT INTERNAL CLOCK COUNTER
00400 IF X=P THEN 390:REM WAIT FOR CHANGE IN COUNTER
00410 P=X:A=A+1
00420 IF A=B THEN T3=T3+3:A=0:REM  3/125 SECOND TIME CORRECTION
00430 IF INT(X/2)<>X/2 THEN 390:REM   USE EVERY 2ND TICK COUNT
00440 T3=T3+1
00450 IF T3>59 THEN T3=T3-60:T2=T2+1:D=1
00460 IF T2>59 THEN T2=0:T1=T1+1:IF T1=12 THEN S2=-S2
00470 IF T1>12 THEN T1=1
00480 POKE 8211,SEG(T3-(INT(T3/10)*10)):POKE 8210,SEG(INT(T3/10))
00490 POKE 8208,SEG(T2-(INT(T2/10)*10)):POKE 8207,SEG(INT(T2/10))
00500 POKE 8205,SEG(T1-(INT(T1/10)*10)):POKE 8204,SEG(INT(T1/10))
00510 IF T1=A1 AND T2=A2 AND S1=S2 AND D=1 THEN Z=90:GOSUB 560:GOTO 390:REM SOUNDALARM
00520 IF Z$="Y" THEN Z=1:GOSUB 560:REM SOUND TICK-TOCK
00530 GOTO 390
00540 REM
00550 D=-D:RETURN :REM  ALARM OFF SUBROUTINE VIA CTL-B
00560 POKE 8201,Z1:PAUSE Z:POKE 8201,Z2:RETURN :REM SOUND ALARM/TICK-TOCK
*
```

Program listing.

DO YOU OWN A PERSONAL COMPUTER?

a PET? an APPLE II? a VIP? a Studio II? a Sorcerer?

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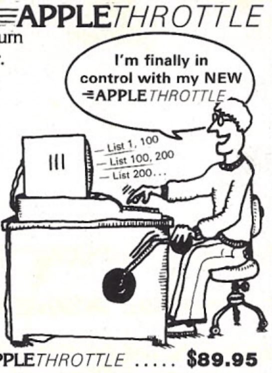

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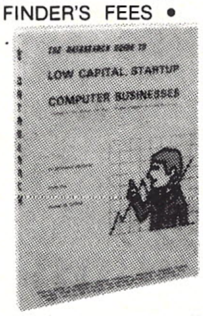

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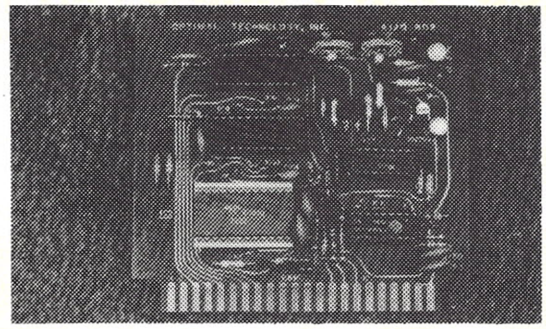

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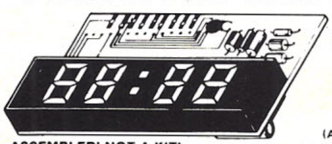

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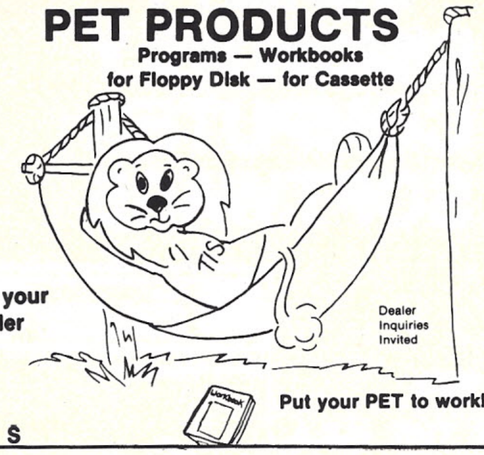

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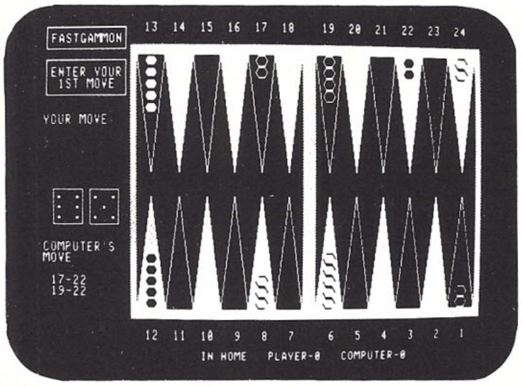

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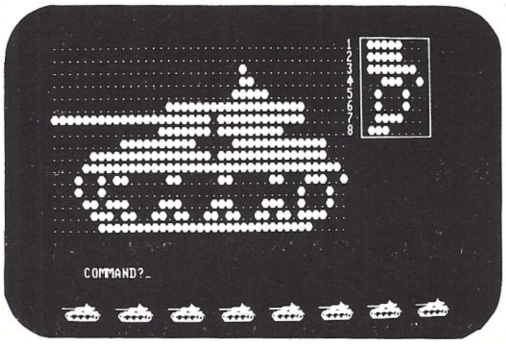

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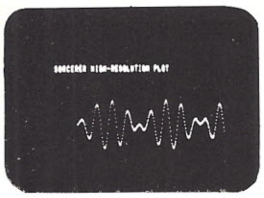

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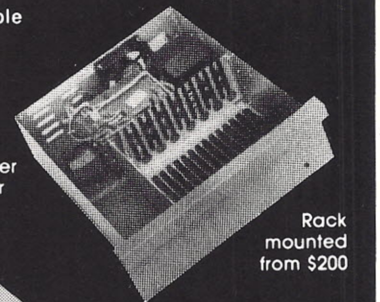

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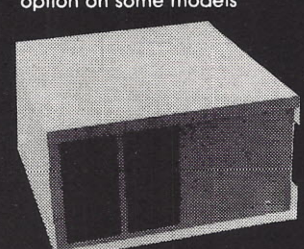

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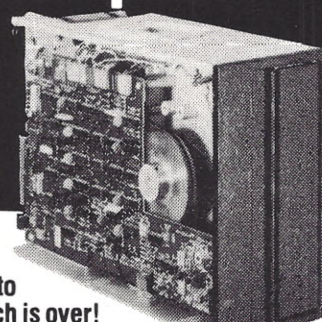

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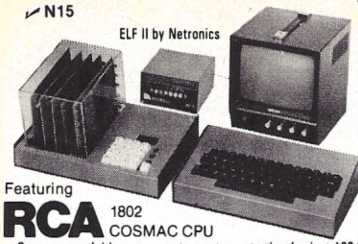

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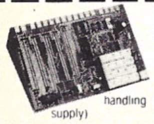

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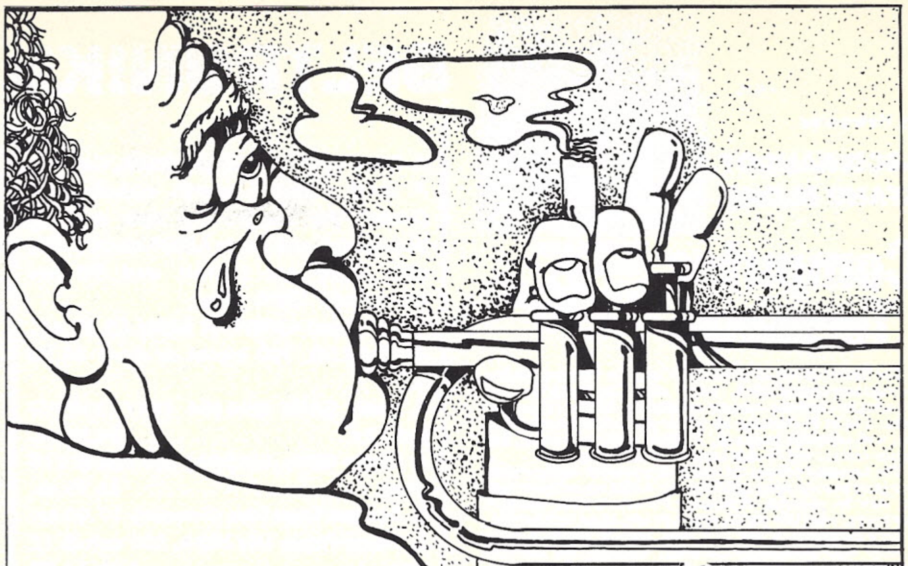

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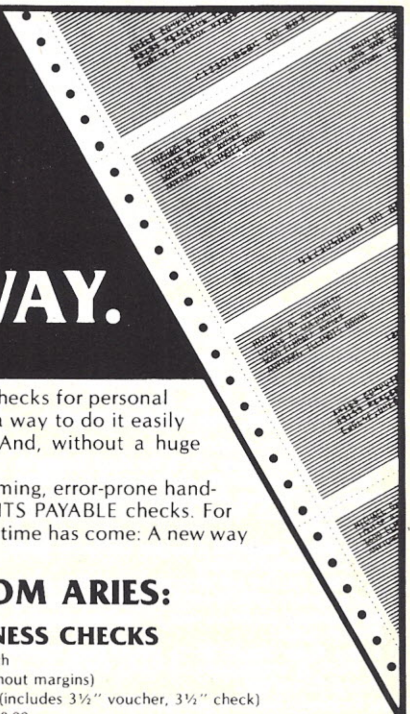

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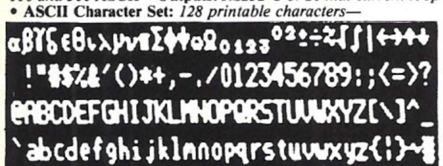

BAUDOT Character Set: *A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? : * 3 $ # ( ) . , 9 0 1 4 ! 5 7 ; 2 / 6 8* • **Cursor Modes:** *Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing* • **Cursor Control:** *Erase, End of Line, Erase of Screen, Form Feed, Delete* • **Monitor Operation:** *50 or 60Hz (jumper selectable.*

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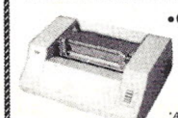

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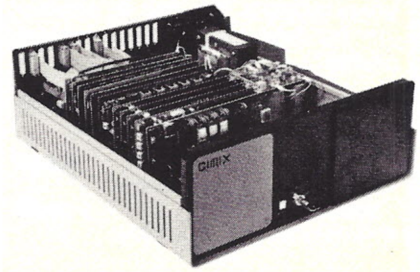

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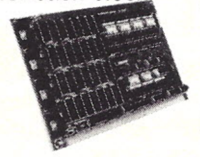

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1979 ARTICLE INDEX

continued from page 187

✓ *Reader Service—see page 227*

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CT-50

SPECIFICATIONS:
- Frequency range: 6 Hz to 65 mHz, 600 mHz with CT-600
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- Input: BNC, 1 megohm/20 pf direct, 50 ohm with CT-600
- Overload: 50VAC maximum, all modes
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The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 mHz and up to 600 mHz with the CT-600 option. Large Scale Integration, CMOS circuitry and solid state display technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation. Features of the CT-50 include: large 8 digit LED display, RF shielded all metal case, easy pushbutton operation, automatic decimal point, fully socketed IC chips and input protection to 50 volts to insure against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step by step instructions guide you to a finished unit you can rely on.

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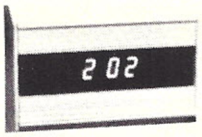
CAR CLOCK



The UN-KIT, only 5 solder connections

Here's a super looking, rugged and accurate auto clock which is a snap to build and install. Clock movement is completely assembled—you only solder 3 wires and 2 switches, takes about 15 minutes! Display is bright green with automatic brightness control photocell—assures you of a highly readable display, day or night. Comes in a satin finish anodized aluminum case which can be attached 5 different ways using 2 sided tape. Choice of silver, black or gold case (specify).

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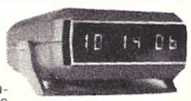
DC-3 wired and tested	$29.95
110V AC adapter	$5.95

Under dash car clock



12/24 hour clock in a beautiful plastic case features: 6 jumbo RED LEDS, high accuracy (1 min/mo.), easy 3 wire hookup, display blanks with ignition, and super instructions. Optional dimmer automatically adjusts display to ambient light level.

DC-11 clock with mtg. bracket	$27.95
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B1-FET mini dip, 741 type	10/$2.00

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RE 6416, terminal card	189.95
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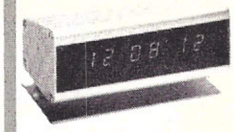
CLOCK KITS



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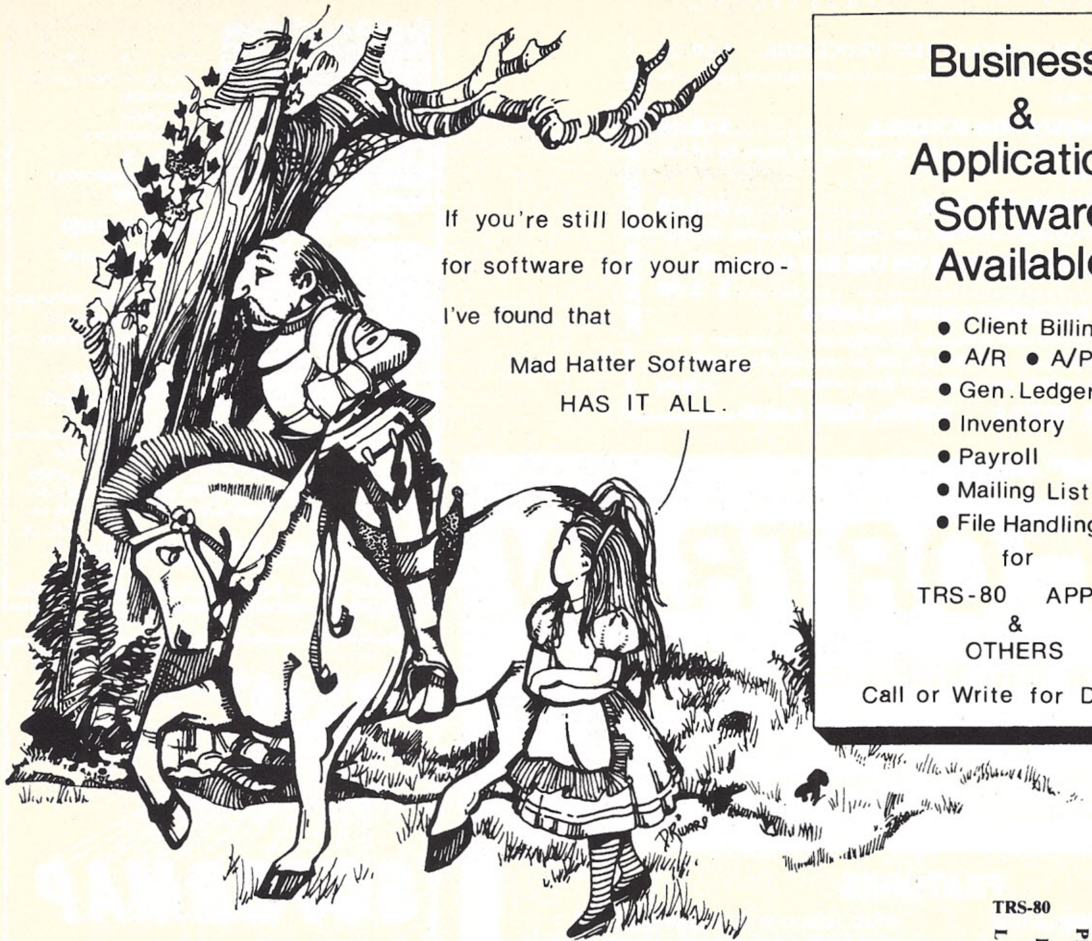

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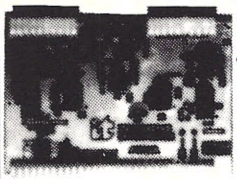

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Experimenters' Paradise. Electronic and mechanical components. Computer People, Audio People, Hams, Robot Builders, Experimenters. Open six days a week. **Gateway Electronics Corp., 8123-25 Page Blvd., St. Louis MO 63130, 427-6116.**

White Plains NY
Processor Technology, North Star HORIZON, Apple II, Commodore PET and KIM; full line of books, components and peripherals; classes in our Seminar Room. **The Computer Corner, 200 Hamilton Avenue, White Plains NY 10601, 949-3282.**

Akron OH
We've got it all. Business systems. Personal systems. Software packages. Custom programming. Terminals. Printers. Service and books. Easy freeway access. 10 AM to 6 PM Monday-Saturday. **The Basic Computer Shop, Fairlawn Plaza, 2671 West Market St., Akron OH 44313, 867-0808.**

Kingston PA
We support Level II and Model II. Books, magazines, programs, parts, accessories, peripherals, free literature, free seminars, cassettes, floppies, filters, transformers, caps, chips, CRTs. **Artco Electronics, 302 Wyoming Ave., Kingston PA 18704, 287-1014.**

Philadelphia/So. Jersey
Intertube II, immediate delivery. Free video terminal comparison, Intertec's SuperBrain, all Centronics printers, Omnitec data modems/couplers, NCR portable modem terminals, MFE digital cassette drives. **L & S Distributors, 44 So. Locust, Marlton NJ 08053, 983-7444.**

York PA
SS-50 Buss Stop. Business & personal systems: Smoke, SWTP, Gimix, MSI, Exidy, TSC, Computerware, Jim-Pak, ACP, etc. Sales & service. Closed Sunday. **G. Y. C. Co., 51 Hamilton Avenue, York PA 17404, 854-0481.**

Houston TX
Experimenters' Paradise! Electronic and mechanical components for computer people, audio people, hams, robot builders, experimenters. Open six days a week. **Gateway Electronics, Inc., 8932 Clarkcrest, Houston TX 77063, 978-6575.**

Dealers: Listings are **$15** per month in prepaid quarterly payments, or one yearly payment of **$150**, also prepaid. Ads include 25 words describing your products and services plus your company name, address and phone. (No area codes or merchandise prices, please.) Call Marcia at 603-924-7138 or write *Kilobaud MICROCOMPUTING*, Ad Department, Peterborough NH 03458.

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SWTPC 6800, CT-64, 12K, AC-30, serial, music & calculator boards, interrupt timer, X'tras, excellent cond. $975 firm. Harold Waxman, 22 Jonathan Ave., Hicksville NY 11801. (516) 822-1091.

For Sale—Elf II, 8K, Giant bd., key bd., power, cases, Tiny BASIC, Elf Bug, lots of programs and articles. All documents. $475. Fred Allen, 3643 Greenwood St., Skokie IL 60076. (312) 679-5372.

PET 2001/8K memory. Like new with manuals and 10 tapes. $550. Call (219) 875-7600 or write Tom Szerencse, 23652 Riverlane Blvd., Elkhart IN 46514.

Hewlett Packard Business Computer—32K with dual single-density 8" floppy, HP BASIC and business software (5 packages) included. Costs $20,000. Will sell for $10,000. Call (816) 531-6884 for details.

For Sale: Morrow's Speakeasy I/O cassette board. Professionally built by me and checked out by Thinker Toys. Will not work with my Z-80 system. $125. Len Stefanelli, 260 Columbus St., Elyria OH 44035. (216) 322-6974.

Dual N. Star mini-floppies with controller, cables and $700 accounts-receivable and gen'l ledger software—$1000. Terminet 300B KSR RS-232 30cps, $700. Integrand mainframe, fully socketed, $275. Cromemco A/R, A/P, G/L, Payroll & Inventory, $350 ea. J. Kelly, 400 W. Madison St., LaGrange KY 40031. (502) 222-0465 evenings.

C1P, Superboard II Owners. Complete, accurate, professional circuit diagram of 600 board; 17" × 22" print; $5. Circuit diagram for TTY interface; $2. Pete Hitt, Box 266, La Luz NM 88337.

TRS-80 computers used in evening adult class. Several memory sizes, disks, Centronics 779 printers, latest modifications. Some software. Jerry Scott, 717 Villa, Watonga OK (405) 623-5805.

We have used ASR-33-Teletypes which can be used as printers for your TRS-80. Hard copy printouts of TRS-80 programs can be yours for only $250. Interface diagram available. Call now! (516) 575-9311, ask for Al or Jim. Limited numbers available!

I want to buy a Heathkit Microprocessor course with components and/or ET-3400 trainer. Greg Allard, Limington ME 04049.

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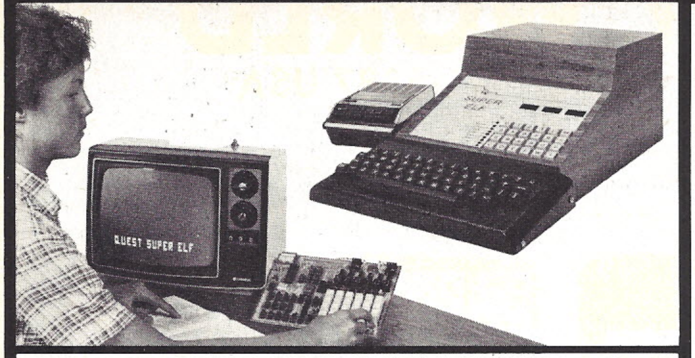

ATTENTION ELF OWNERS: QUEST SUPER BASIC

Quest, the leader in inexpensive 1802 systems announces another first. Quest is the first company worldwide to ship a full size *Basic* for 1802 systems. A complete function Super Basic by Ron Cenker including floating point capability with scientific notation (number range $\pm .17E^{38}$), 32 bit integer ± 2 billion, Multi dim arrays, String arrays, String manipulation, Cassette I/O, Save and load, Basic, Data and machine language programs and over 75 Statements, Functions and Operators.

Easily adaptable on most 1802 systems. Requires 12K RAM minimum for Basic and user programs. Cassette version in stock now. ROM versions coming soon with exchange privilege allowing some credit for cassette version.

Super Basic on Cassette **$40.00**

Tom Pittman's 1802 Tiny Basic Source listing now available. Find out how Tom Pittman wrote Tiny Basic and how to get the most out of it. Never offered before. **$19.00**

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16K Dynam. RAM bd. expand. 32K; less than $150.

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Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded** with **additional memory, Full Basic, ASCII Keyboards, video character generation, etc.**

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high** and **low address**. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** Expansion Cabinet with room for 4 S-100 boards **$41.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic Cassette **$10.00,** on ROM **$38.00,** original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50.** Games and Music **$3.00,** Chip 8 Interpreter **$5.50.**

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This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface.** Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf.** The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed.** EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake.** They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $12.50 for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system (see Multi-volt Power Supply below).

Multi-volt Computer Power Supply

8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12 option. ±5v, ±12v are regulated. Kit $29.95. Kit with punched frame $37.45, $4.00 shipping. Woodgrain case $10.00, $1.50 shipping.

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7402N	.18
7404N	.19
7409N	.23
7410N	.18
7414N	.70
7420N	.18
7422N	.39
7430N	.20
7442N	.50
7445N	.69
7447N	.60
7448N	.69
7450N	.18
7474N	.35
7475N	.49
7485N	.88
7489N	1.85
7490N	.43
7492N	.43
7493N	.43
7495N	.69
74100N	.90
74107N	.35
74121N	.34
74123N	.59
74125N	.45
74145N	.69
74150N	.95
74151N	.69
74154N	1.00
74157N	.69
74161N	.87
74162N	.87
74163N	.87
74174N	.96
74175N	.90
74190N	1.15
74192N	.87
74193N	.85
74221N	2.00
74298N	1.65
74365N	.66
74366N	.66
74367N	.66

74LS00 TTL

74LS00N	.35
74LS02N	.35
74LS04N	.35
74LS05N	.35
74LS08N	.35
74LS10N	.35
74LS13N	.55
74LS14N	1.10
74LS20N	.35
74LS22N	.35
74LS28N	.41
74LS30N	.35
74LS33N	.75
74LS38N	.55
74LS74N	1.25
74LS75N	1.00
74LS90N	.85
74LS93N	.70
74LS95N	1.10
74LS107N	.45
74LS112N	.45
74LS113N	.35
74LS132N	.89
74LS136N	.45
74LS151N	.85
74LS155N	.85
74LS157N	.85
74LS162N	1.15
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LM320T-8	1.60
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LM320T-15	1.60
LM324N	1.15
LM339N	1.55
LM340K-5	1.35
LM340K-8	1.35
LM340K-12	1.35
LM340K-15	1.35
LM340K-24	1.35
LM340T-5	1.25
LM340T-8	1.25
LM340T-12	1.25
LM340T-15	1.25
LM340T-18	1.25
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LM741N	.32
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CD4018	.94
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CD4020	1.02
CD4021	1.25
CD4022	1.10
CD4023	.28
CD4024	.75
CD4025	.28
CD4026	2.00
CD4027	.66
CD4028	.85
CD4029	1.02
CD4030	.45
CD4035	1.02
CD4040	1.02
CD4042	.85
CD4043	.85
CD4044	.85
CD4046	1.67
CD4049	.45
CD4050	.49
CD4051	1.13
CD4060	1.42
CD4066	.71
CD4068	.40
CD4069	.40
CD4070	.50
CD4071	.28
CD4072	.28
CD4073	.28
CD4075	.28
CD4076	1.45
CD4078	.40
CD4081	.28
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16	.16	28	.42
18	.27	36	.58
20	.29	40	.57

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MAN1	CA	.270	2.90
MAN3	CC	.125	.39
MAN72/74	CA/CA	.300	1.00
DL704	CC	.300	1.25
DL707/DL707R	CA	.300	1.00
DL727/728	CA/CC	.500	1.90
DL747/750	CA/CC	.600	1.95
DL750	CC	.600	1.95
FND359	CC	.357	.70
FND500/507	CC/CA	.500	1.35
FND503/510	CC/CA	.500	.90
FND800/807	CC/CA	.800	2.20
3 digit Bubble			.60
4 digit Bubble			.80
DG8 Fluorescent			1.75
DG10 Fluorescent			1.75
5 digit 14 pin display			1.00
NSN69 9 digit display			.60
7520 Clairex photocells			.39
TIL311 Hex			9.50
MAN3640	CC	.30	1.10
MAN4610	CA	.40	1.20
MAN4640	CC	.40	1.20
MAN4710	CA	.40	.95
MAN4740	CC	.40	1.20
MAN6640	CC	.56	2.95
MAN6710	CA	.60	1.35
MAN6740	CC	.60	1.35
MA1002A		**8.95**	
MA1012A		**8.95**	
102P3 transformer		**2.25**	

Rockwell AIM 65 Computer

6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display, ROM monitor, fully expandable. $375.00. 4K version $450.00. 4K Assembler $85.00, 8K Basic Interpreter $100.00. Power supply assy. in case $60.00. AIM 65 in thin briefcase with power supply $485.00.

Not a Cheap Clock Kit $14.95

Includes everything except case. 2-PC boards. 6-.50" LED Displays. 5314 clock chip, transformer, all components and full instructions. Orange displays also avail. **Same kit w/.80" displays.** Red only. **$21.95** Case **$11.75**

Video Modulator Kit $8.95

Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

S-100 Computer Boards

8K Static RAM Kit Godbout	$135.00
16K Static RAM Kit	265.00
24K Static RAM Kit	423.00
32K Dynamic RAM Kit	310.00
32K Static RAM Kit	**$475.00**
64K Dynamic RAM Kit	470.00
8K/16K Eprom Kit (less PROMS)	**$89.00**
Video Interface Kit	**$139.00**
Motherboard **$39.** Extender Board	**$8.99**

79 IC Update Master Manual $35.00

Complete IC data selector, 2500 pg. master reference guide. Over 50,000 cross references. Free update service through 1979. Domestic postage $3.50. No foreign orders.

Auto Clock Kit $17.95

DC clock with 4-.50" displays. Uses National MA-1012 module with alarm option. Includes light dimmer, crystal timebase PC boards. Fully regulated, comp. instructs. Add $3.95 for beautiful dark gray case. Best value anywhere.

Stopwatch Kit $26.95

Full six digit battery operated. 2–5 volts. 3.2768 MHz crystal accuracy. Times to 59 min., 59 sec., 99 1/100 sec. Times std., split and Taylor. 7205 chip, all components minus case. Full instructions.

NiCad Battery Fixer/Charger Kit

Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/full parts and instructions. **$7.25**

PROM Eraser

Will erase 25 PROMs in 15 minutes. Ultraviolet, assembled **$34.50**

Hickok 3½ Digit LCD Multimeter

Batt/AC oper. 0.1mv–1000v. 5 ranges. 0.5% accur. Resistance 6 low power ranges 0.1 ohm–20M ohm. DC curr. .01 to 100ma. Hand held, ½" LCD displays, auto zero, polarity, overrange. **$69.95.**

Digital Temp. Meter Kit $34.00

Indoor and outdoor. Switches back and forth. Beautiful. 50" LED readouts. Nothing like it available. Needs no additional parts for complete, full operation. Will measure −100° to +200°F, tenths of a degree, air or liquid. Beautiful woodgrain case w/bezel **$11.75**

TERMS: $5.00 min. order U.S. Funds. Calif residents add 6% tax.
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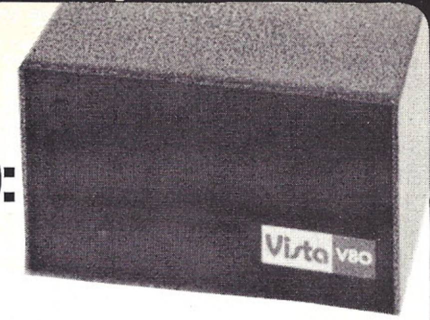
Shipping charges will be added on charge cards.

FREE: Send for your copy of our NEW 1979 QUEST CATALOG. Include 28¢ stamp.

Memory War Shop and Compare

The Vista V80:



$395.00

widen the ability of your TRS-80

The Vista V80 Mini Disk System is the perfect way to widen the capabilities of your TRS-80* Micro-computer. Quickly and inexpensively. Our $395 price tag is about $100 less than the Radio Shack equivalent. Our delivery time is immediate. And our system is fully interchangeable. That's just the start.

It will give you 23% more storage capacity by increasing useable storage from 55,000 to 65,000 bytes per drive with our new software patch.

It can work 8 times faster than the TRS-80 Mini-Disk system, because track-to-track access is 5ms versus 40ms for the TRS-80. You can realize this added speed once the new double disk expansion interface is available without expensive modification of the existing unit.

It has a better warranty than any comparable unit warranty available - a full 120 days on all parts and service. When you consider how much more goes into the Vista V80, that shows a lot of faith in our product.

A full 3 amp power supply means you have 2½ times the power necessary to operate the V80, and full ventilation insures that there will be no problems due to overheating.

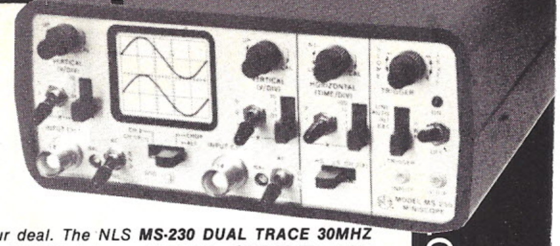
The Vista V80 Mini Disk System requires Level II Basic with 16K RAM Expansion interface (it operates from the Radio Shack interface system. It comes complete with a dependable MPI Minifloppy disk drive, power supply, regulator board and vented case. It's shipped to you ready to run-simply take it out of the box and plug it in. You're in business. From the company that means business -Vista Computer Company.

DATA CABLES, VC80-2 (2 drive) **$29.95**
VC80-4 (4 drive) **$39.95**

SPECIAL: Box of 10 DISKETTES
$20.00 with Purchase of VISTA 80

FREE 15MHZ DUAL TRACE SCOPE* SAVE $124.00

NLS



*no not really, but here is our deal. The NLS **MS-230 DUAL TRACE 30MHZ MINISCOPE,** regularly sells for **$559.00,** but we will sell it for **$435.00** (The price of the MS-215 Dual Trace 15 MHZ Miniscope) when you **purchase** any **2 probes** listed below and your order prepaid or paid by credit card.*

•30-Megahertz bandwidth•Accuracy 3% full scale.•Internal, line or external trigger.•Batteries and charger/transformer unit included•Graticule: 4 x 5 divisions, each division 0.25"•Time base: 1 micro sec. to 0.5 sec/div 21 settings•Verticle Gain: 0.01 to 50 Volts/div. 12 settings•Size2.9"H x 6.4" W x 8.5"D. 3.5 lbs. • TEST MOST DIGITAL LOGIC CIRCUITS INCLUDING MICROPROCESSORS•

MS-230 Dual Trace 30 MHz	~~$500~~ $435.00
41-141 Deluxe 10tol probe with 4 interchangeable tips	$27.00
41-37 Deluxe 10tol/1tol probe with 4 interchangeable tips	$38.50
41-180 Leather carrying case	$45.00
MS-15 Single trace 15 MHz	$318.00
MS-215 Dual trace 15 MHz	$435.00

M-XVI

SHOP & COMPARE

California Computer Systems

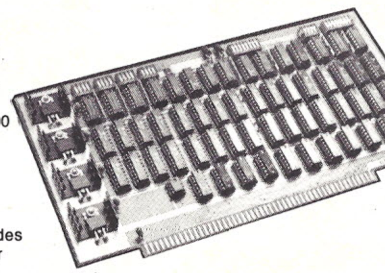
The true 16K Static Ram module for S-100 bus systems.

ASSEMBLED & TESTED--100% BURN IN

The M-XVI gives you unbelievable expansion capability for your S-100 bus system—even beyond 64K. Manufactured to the highest industry standards documented and designed to make assembly, use, and programming a snap. The M-XVI board is a true revelation for the serious hobbyist and use in practical business or industrial applications.

FEATURES:
- Fully static
- Uses popular 2114 static RAMS
- +5 volt operation only
- Bank Select available by bank port and bank byte
- Phantom line capability
- Addressable in 4K blocks
- 4K blocks can be addressed anywhere within 64K in 4k increments
- Meets IEEE proposed S-100 signal standards
- LED indicators for board selection and bank selection
- FR-4 epoxy PC boards
- Solder masked on both sides
- Silk screen of part number and part designator

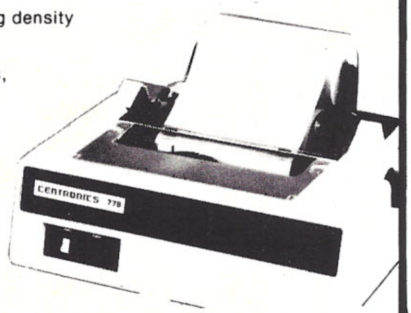
SPECIAL



		Sale Priced
2016BA 450ns 2MHZ	Reg. ~~$349.95~~	**$295.00**
2016BB 300ns 4MHZ	Reg. ~~$389.95~~	**$329.00**
2016BY Bare Board only		**$29.95**

CENTRONICS 779 PRINTERS

- Use with TRS-80
- Parallel interface
- Continuous variable printing density 80-132 characters per line
- 5x7 dot matrix
- Prints on plain paper, sheets, rolls, fan fold
- Form thickness control
- Horizontal and vertical form positioning



779-1 pinch roll friction feed
Reg. $1250 **$950.00**
779-2 tractor feed
Reg. $1400 **$1050.00**

CENTRONICS 730 PRINTERS — REG. ~~$895.~~
730-1 PARALLEL INTERFACE — **$850.**
730-3 RS-232 INTERFACE — Reg. ~~$1,045.~~
SHOP and COMPARE — **$895.**

3M Scotch® Brand DISKETTES

Part#	Sides/ Density	Sectoring	Price Box of 10
		8"	
740-OP	1/single	Soft-IBM	$39.95
740/2-OP	2/single	Soft-IBM	$75.00
740-32P	1/single	32-Shugart 801	$39.95
740/2-32P	2/single	32-Shugart 801	$75.00
741-0	1/double	Soft-Shugart Dbl	$59.00
		5"	
744-OK	1/single	Soft-Shugart SA400 (TRS-80)	$51.00*
744-10K	1/single	Soft/10 SA400	$51.00*
744-16K	1/single	Soft/16 Micropolis	$51.00*

***Price includes Kas-ette/10 Storage Box a $5.00 Value (TRS-80)**

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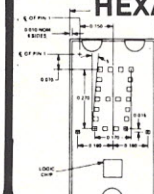
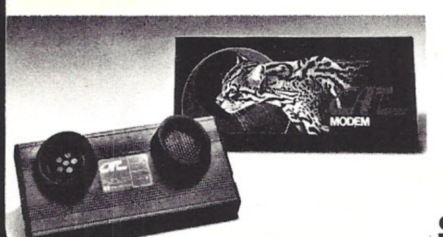
TYPE TIL311/1707 HEXADECIMAL DISPLAY WITH LOGIC



$9.95 ea. or 4/$34.95

NOVATION CAT ACOUSTIC MODEM



- 0-300 Baud
- Bell 103
- Answer, Originate

Regular ~~$198.00~~

Sale $189.00

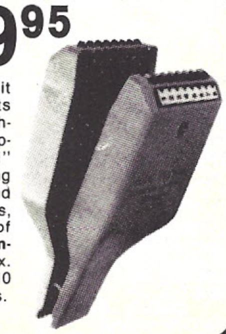
CONTINENTAL SPECIALTIES CORPORATION

CSC

$59.95

LOGIC MONITOR 1

Trace signals through all types of digital circuits. Unit clips over any DIP IC up to 16 pins. Each of its 16 contacts connects to a single-bit level detector that drives a high-intensity, numbered LED readout activated when the applied voltage exceeds a fixed 2 V threshold. Logic "1" turns LED on; logic "0" keeps LED off. A power-seeking gate network automatically locates supply leads and feeds them to the LM-1's internal circuitry. Saves minutes, even hours in design, troubleshooting, debugging of equipment. **Voltage Threshold:** 2 V ± 0.2 V. **Input Impedance:** 100,000 ohms. **Input Voltage Range:** 4-15 V max. across any two or more inputs. **Current Drain:** 200 mA at 10 V. **Size:** 4" l. x 2" w. x 1.75" d. when open. **Weight:** 3 ozs.



CSC Model LM-1 Logic Monitor—Complete.

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HICKOK LX303

$74.95*

.5%, 3½ digit 19 Range DVM. ½" LCD displays runs 200 hrs on 1 battery. 10 Meg Ohm Input. 1 yr. guarantee, made in U.S.A., test leads included.

Available Accessories

- **RC-3** 115V AC Adapter **$7.50**
- **CC-3** Deluxe Padded Vinyl Carrying Case **$7.50**
- **VP-10** X10 DCV Probe Adapter/ Protector 10Kv **$14.95**
- **VP-40** 40Kv DC Probe **$35.00**
- **CS-1** 10 Amp Current Shunt **$14.95**

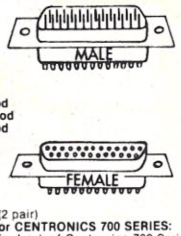
***FREE**

Just for Asking.
FREE BATTERY with your meter.

RS232 & "D" TYPE CONNECTORS

P = Plug-Male S = Socket-Female C = Cover-Hood

PART NO.	DESCRIPTION	PRICE 1-4	5-9	10-24
DE-9P	9 Pin Male	1.50	1.30	1.20
DE-9S	9 Pin Female	2.15	2.05	1.95
DE-9C	9 Pin Cover	1.50	1.30	1.15
DA15P	15 Pin Male	2.20	2.00	1.80
DA15S	15 Pin Female	3.20	3.00	2.80
DA15C	15 Pin Cover	1.60	1.45	1.30
DB-25P	25 Pin Male	2.90	2.60	2.50
DB-25S	25 Pin Female	3.75	3.65	3.40
DB51212-1	1 pc. Grey Hood	1.65	1.40	1.20
DB1226-1A	2 pc. Black Hood	1.90	1.60	1.50
DB110963-3	2 pc. Grey Hood	1.80	1.55	1.35
DC37P	37 Pin Male	3.95	3.80	3.60
DC37S	37 Pin Female	5.75	5.50	5.20
DC37C	37 Pin Cover	2.20	1.95	1.75
DD50P	50 Pin Male	4.95	4.75	4.50
DD50S	50 Pin Female	7.50	7.20	6.90
DD50C	50 Pin Cover	2.50	2.20	2.10
D20418-S	Hardware Set (2 pair)	1.00	.80	.70



Connector for CENTRONICS 700 SERIES:
Amphenol 57-30360 for back of Centronics 700 Series printers
1-4—$9.00 5-up—$7.50

3 LEVEL GOLD WIRE WRAP SOCKETS

Sockets purchased in multiples of 50 per type may be combined for best price.

	1-9	10-24	25-99	100-249	250-999
8 pin	.40	.36	.34	.31	.27
14 pin	.39	.38	.36	.34	.32
16 pin	.50	.42	.40	.36	.34
18 pin	.70	.60	.55	.50	.45
20 pin	.90	.80	.75	.65	.62
22 pin	.95	.85	.80	.70	.65
24 pin	.95	.85	.80	.70	.65
28 pin	1.25	1.15	1.00	.95	.90
40 pin	1.65	1.45	1.35	1.20	1.10

All sockets are GOLD 3 level closed entry. 2 level Tail, Low Profile, Tin Sockets and Dip Plugs available. CALL FOR QUOTATION.

SALE S-100 BUS EDGE CONNECTORS SALE

S100-WWG 50/100 Cont. .125 ctrs. 3 LEVEL WIRE WRAP .025" sq. posts on .250 spaced rows. GOLD PLATED.

1-4	5-9	10-24
$4.00	$3.75	$3.50

S100-STG 50/100 Cont. .125 ctrs. DIP SOLDER TAIL on .250 spaced rows for VECTOR, IMSAI, CROMENCO mother-boards GOLD plated.

1-4	5-9	10-24
$3.50	$3.25	$3.00

S100ALT 50/100 Cont. .125 ctrs. DIP SOLDER TAIL on .140 spaced rows for ALTAIR motherboards. GOLD plated.

1-4	5-9	10-24
$4.50	$4.25	$4.00

S100SE 50/100 Cont. .125 ctrs. PIERCED SOLDER EYELET tails. GOLD

1-4	5-9	10-24
$5.00	$4.50	$4.00

Other Popular Edge Connectors

D2244-5SE 22/44 Cont. .156 ctrs. PIERCED SOLDER EYELET tails. GOLD plated.

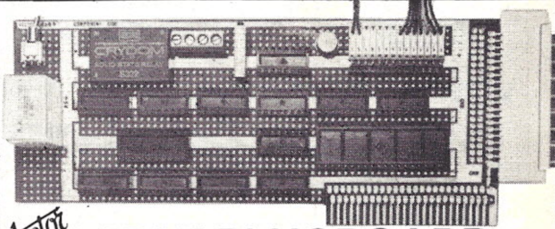
1-4	5-9	10-24
$3.00	$2.60	$2.20

D2244-5WW 22/44 Cont. .156 ctrs. WIRE WRAP tails. GOLD.

1-4	5-9	10-24
$3.95	$3.70	$3.40

CG-1 IMSAI Style Card Guides 5/$1.00

See our July Ad for many other connectors.



Vector APPLE PLUGBOARD

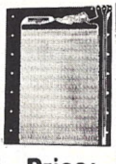
Vector 4609 Peripheral Interface Plugboard for construction of custom circuits. Plug compatible with Apple II, Commodore PET and Super Kim microcomputers. Three connectors, in addition to the standard 25/50 system bus, are available for input/output. A 20/40-contact card-edge connector, fabricated on the rear of the board, mates with a 3-M type ribbon connector. Alternatively, a right-angle solder-tail header may be positioned in this same location. The Model 4609 also accomodates the miniature SIP-type connectors which may be placed on the periphery or in mid-board.

1-4	5-9	10-24
$21.50	$19.36	$17.26

7520 APPLE EXTENDER CARD $24.95

8803 MOTHER BOARD FOR S100 BUS MICRO-COMPUTERS — Vector

- Kit includes 12 tantalum capacitors for +5, +12, —12 buses and insulated mounting spacers.
- Wiring side shown. Component side bare epoxy glass with white markings for component locations.
- G10 epoxy glass board with 2 ounce copper, solder plated and .038 diameter holes for leads.
- Solder mask with solder windows on etched circuits to avoid accidental short circuits.
- Mounts 11 receptacles with 100 contacts (2 rows) on .125 centers with .250 row spacing. Vector part number R681-2; or mounts 10 receptacles plus interconnections to smaller mother board for expansion.
- Includes etched circuits and instructions for option of active, pull-up, or floating terminations.
- Large buses: +5V and GND (10 AMPS), ± 12V or 16V (7 AMPS). Current ratings are per MIL-STD-275 with 10ºC rise.
- Fits in Vector-pak enclosures.
- Fits in IMSAI 8080 microcomputer as expander board.



Price: $29.50

Vector Plugboards

8800V
Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware. 5.3" x 10" x 1/16"

1-4	5-9	10-24
$19.95	$17.95	$15.96

8801-1
Same as 8800V except plain; less power buses & heat sink.

1-4	5-9	10-24
$15.22	$13.79	$12.18

3682 9.6" x 4.5" **$12.97**
3682-2 6.5" x 4.5" **$9.81**
Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156

3677 9.6" x 4.5" **$10.90**
3677-2 6.5" x 4.5" **$9.74**
Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin c n. spaced .156

3662 6.5" x 4.5" **$8.95**
3662-2 9.6" x 4.5" **$11.45**
P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156

3690-12
CARD EXTENDER
Card Extender has 100 contacts 50 per side on .125 centers-Attached connector-is compatible with S-100 Bus Systems. **$25.83**
3690 6.5" 22/44 pin .156 ctrs. Extenders $13.17

1/16 Vector BOARD

.042 dia holes on 0.1 spacing for IC's

Phenolic PART NO.	SIZE	PRICE 1-9	10-19
64P44XXXP	4.5x6.5"	$1.56	$1.40
169P44XXXP	4.5x17"	$3.69	$3.32
Epoxy Glass			
64P44	4.5x6.5"	$1.79	$1.61
84P44	4.5x8.5"	$2.21	$1.99
169P44	4.5x17"	$4.52	$4.07
169P84	8.5x17"	$8.83	$7.95

TRS-80/APPLE MEMORY EXPANSION KITS

4116's RAMS
from Leading Manufacturers
(16Kx1 200/250ns)
1,000's SETS SOLD! 100% GUARANTEED

8 for $75.00

Add $3.00 for programming Jumpers for TRS-80 Keyboard

Extender/ Terminator

—NEW— S-100

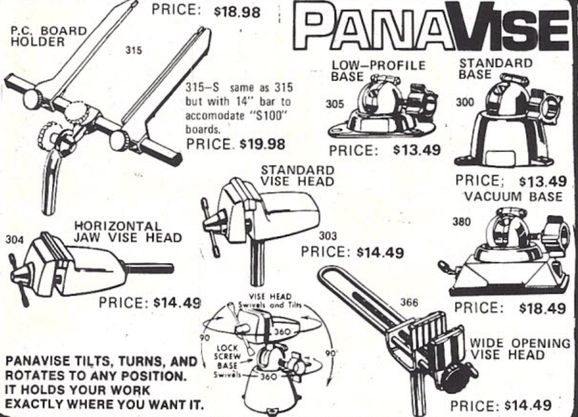
- Active and/or dynamic termination
- All power lines fused for protection
- All S-100 lines labeled and numbered
- Can be used as an extender and/or terminator
- Solder mask both sides of board
- Silkscreened reference designations
- Gold plated fingers

Cat.No.2520 KIT **$39.95**

WOW! 14 & 16 PIN GOLD 3 LEVEL WIRE WRAP SOCKES

14 - G3 100 for **$33.00**
16 - G3 100 for **$33.00**
50 of each for **$35.00**

PANAVISE



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MEMORY MEMORY

2102LIPC	Low Power 450ns in lots of 25	$1.10
2102AL-2	Low Power 250ns in lots of 25	$1.25
2114-3L	1Kx4 300 ns Low Power	8/$50.00
5257-3L	4Kx1 300ns Low Power	8/$50.00
2708	8K 450ns EPROM	8/65.00 $9.00
2716	16K 5 Volt Only EPROM	$40.00

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SPECIAL
$56.95 with tube

Perfectly balanced fluorescent lighting with precision magnifier lens. Tough thermoplastic shade. Easy lens removal. New wire clip design permits easy installation and removal of fluorescent tube. Comes with plastic shield to protect tube from soiling and damage.
Colors: Gray, Black, and Chocolate Brown. Comes with one 22 watt T-9 Circline fluorescent tube. 3 diopter lens.

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except CA., AK., HI., Call (213) 894-8171

Vector WRAP POST

for .042 dia. holes
(all boards on this page)

- **T44/C** pkg. 100 . . **$ 2.34**
- **T44/M** pkg. 1000 .... **$14.35**
- **A-13** hand installing tool .... **$ 4.19**

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Prices subject to change without notice.
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Monolithic Ceramic Bypass Capacitors .2" lead Spacing

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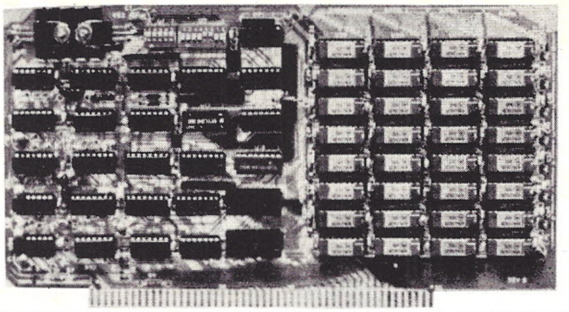
SD EXPANDORAM
The Ultimate S-100 Memory



The EXPANDORAM is available in versions from 16K up to 64K, so for a minimum investment you can have a memory system that will grow with your needs. This is a dynamic memory with the invisable on-board refresh, and IT WORKS!

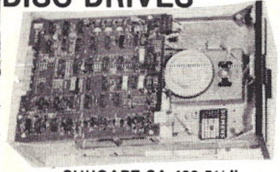
- Interfaces with Altair, IMSAI, SOL-8, Cromenco, SBC-100, and others.
- Bank Selectable
- Phantom
- Power 8VDC, ± 16VDC, 5 Watts
- Lowest Cost Per Bit
- Uses Popular 4116 RAMS
- PC Board is doubled solder masked and has silk-screen parts layout.

- Extensive documentation clearly written
- Complete Kit includes all Sockets for 64K
- Memory access time: 375ns, Cycle time: 500ns.
- No wait states required.
- 16K boundries and Protection via Dip Switches
- Designed to work with Z-80, 8080, 8085 CPU's.

EXPANDO 64 KIT (4116)

		SALE PRICE
16K	~~$249~~	$219
32K	~~$324~~	$285
48K	~~$398~~	$350
64K	~~$474~~	$415

DISC DRIVES



SHUGART SA 400 5¼"
110 KB, 35 tracks,
SHUGART SA 400 **$295.00**

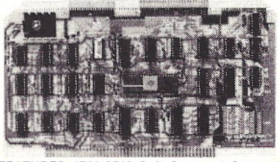
SHUGART SA 400
with attractive metal case with cutouts for Data Cable switch, fuse and power cord.
LOBO SA400-C **$325.00**

SHUGART SA400
with Cabinet and Power Supply. Assembled, tested & guaranteed
LOBO SA400-PSC **$395.00**

SHUGART 801R 8"
6.4 megabits, single or double density, hard or soft sector, write protect, and more
SHUGART 801R **$495.00**

Siemens FDD 200-8 8"
double-sided double density
$650.00

DISC CONTROLLER
SD "VERSAFLOPPY" Kit
The Versatile Floppy Disk Controller **ONLY $145.00**

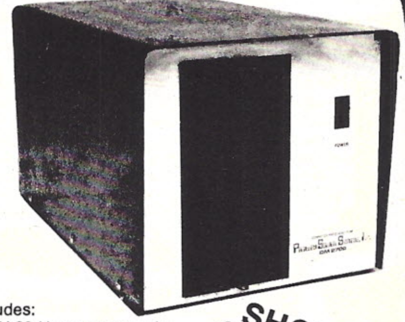


FEATURES: IBM 3740 Soft Sectored Compatible. S-100 BUS Compatible for Z-80 or 8080. Controls up to 4 Drives (single or double sided). Directly controls the following drives:
1. Shugart SA400/450 Mini Floppy
2. Shugart SA800/850 Standard Floppy.
3. PERSCI 70 and 277.
4. MFE 700/750.
5. CDC 9404/9406.
6. GSI/Siemans FDD120-8.

34 Pin Connector for Mini Floppy. 50 Pin Connector for Standard Floppy. Operates with modified CP/M operating system and C-Basic Comptler. The new "Versafloppy" from S.D. Computer Products provides complete control for many of the available Floppy Disk Drives, Both Mini and Full Size. FD1771B-1 Single Density Controller Chip. Listings for Control Software are included in price.

CPM for SD Versafloppy **$100.00**

SAVE $100.00
DM2700S DISK & CABINET with POWER SUPPLY



DM2700S includes Siemans FD120-8" Disk Drive with the following features:

- Single or Double Density
- Hard or Soft Sector
- Door Interlock
- Write Protect
- Hard Sector Detection
- 500 KB/S Transfer
- 800 KB unformated
- Bit density 6536 BP1
- Sugart 800 Series Compatable

Cabinet includes:
- 110V to 125V 60 Hz power supply
- Data Cable
- Fan
- Accepts per SCI, Shugart, Siemans 8" Drives

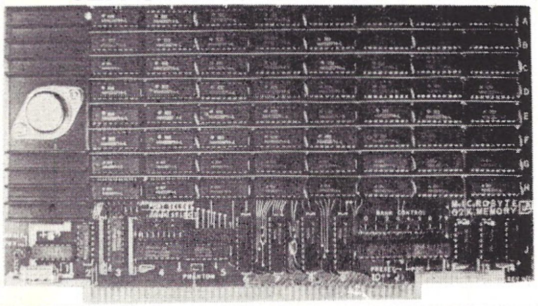
SHOP & COMPARE

DM2700S Disk Drive & Cabinet REG. $750 SALE PRICED **$650.00**

DM2700 Cabinet, less Drive **$249.00** **$225.00**

THE MICROBYTE M32KSS 32K STATIC MEMORY BOARD

SAVE $120.00



ASSEMBLED & TESTED
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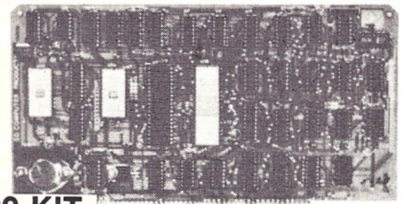
M32 KSS-L (2 MHz)
List $650 SALE **$530.00**

M32 KSS-H (4 MHz)
List $680 SALE **$560.00**

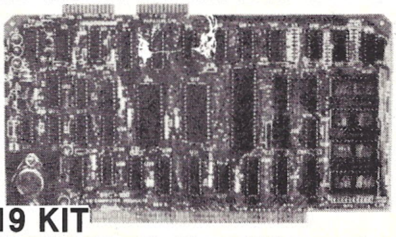
• Fully S100 Bus Compatible, IMSAI, SOL, ALTAIR, ALPHA MICRO. • Uses National's Low Power 5257 4K x 1 Static Rams. • 2 MHz or 4 MHz operation. • Gold contacts for higher reliability. • On board single 5 amp regulator. • Thermally designed heat sink (board operating temperature 0° — 70°C). • Commercially designed power bus, 7 ground bus bars, 0.1 uf decoupling capacitors. • Fully tri-state buffered. • Inputs fully low power Shottky Schmitt, Trigger buffered on all address and data lines. • Phantom is jumper selectable to pin 67. • Each 4K bank addressable to any 4K slot with in a 64K boundary. • 4K hardware or software selectable. • One on board 8-bit output port enables or disables the 32K in 4K blocks. • Selectable port address. • 4K banks can be selected or disabled on power on clear or reset. • Will operate with or without front panel. • Compatible with ALPHA MICRO, with extended memory management for selection beyond 64K. • No DMA restriction. • Low power consumption 2.3 — 2.5 amps. • Fully warranted for 120 days from date of shipment.

SD COMPUTER BOARDS



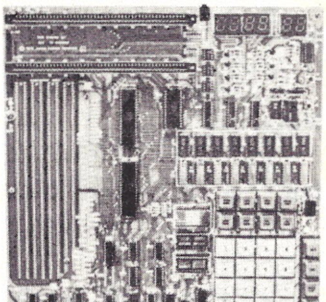
$299 KIT
VDB-8024 Video Display Board
With On-Board Z80 Microprocessor

- Full 80 Characters by 24 lines display
- Characters displayed by High Resolution 7×10 Matrix
- Keyboard Power and Interface
- Composite Video Output
- Separate TTL Level Synchronization and Video Outputs
- 2K Bytes Independent On Board Memory
- On-Board Z80 Microprocessor
- Glich Free Display
- 96 Upper and Lower Case Characters
- 32 Special Character Set
- 128 Additional user Programmable Characters
- Full Cursor Control
- Forward and Reverse Scrolling Capability
- Operates as an Independent Terminal
- Variable Speed Display Rate
- Blinking, Underlining, Field Reverse, Field Protect and Combinations



$219 KIT
SBC-100 Single Board Computer
with On-board RAM, PROM, CTC

- Four Channel Counter/Timer (Z80-CTC)
- Software Programmable Baud Rate Generator
- S-100 Bus Compatible
- No Front Panel Required for Operation
- Optional Vectored Interrupts
- Z80Central Processing Unit
- 1024 Bytes of Random Access Memory
- 8K Bytes of Available PROM
- Serial Input/Output Port with both Synchronous and Asynchronous Operation
- Parallel Input and Output Ports



$225
Z80 Starter Kit
A Complete Microcomputer on a Board

- Z80 Central Processing Unit with 158 Instructions
- On Board Keyboard and Display
- Kansas City Standard Cassette Interface
- PROM Programmer Built on-board
- Expansion provision for two S-100 Connectors
- Wire Wrap area for custom circuitry
- Single 5 Volt Operation when not programming
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- 1K Bytes of RAM (Expandable to 2K Bytes)
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- 2K Byte ZBUG Monitor in ROM
- Memory Examine and Change
- Port Examine and Change
- Z80 CPU Register Examine and Change
- Up to 5 Programmable Breakpoints
- Single Step through RAM or PROM
- Audio Cassette Load and Dump
- Vectored Interrupts provided by Z80-CTC and Z80-PIO
- Ideal for Experimentaion and Evaluating the Z80 CPU

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3rd Generation S-100: Chosen by Professionals, Supported by CompuPro™

Why S-100? Because S-100 machines are not consumer-oriented, all-in-one microcomputers — but flexible, modular, professional-level systems that are easy to upgrade, modify, and adapt to specific applications. As a result, over the years the S-100 buss has proven to be the ideal choice for commercial, industrial, and scientific applications. It doesn't obsolete itself, but simply adapts to innovation.

We use the experience we've acquired in the past, coupled with the very best technology offered by the present, to build products for the future . . . products that meet, and often exceed, the demands of the new wave of professional S-100 users. Our expanded S-100 line is the right approach at the right time; we invite you to write for further information.

NEW! HIGH-PERFORMANCE S-100 MOTHERBOARDS

19 slot: $174 unkit*, $214 assm
12 slot: $129 unkit*, $169 assm
6 slot: $ 89 unkit*, $129 assm

*Edge connectors and termination resistors are pre-soldered in place for assembly.

These 3rd generation motherboards, designed to work with the latest 5 and 10 MHz CPUs coming on line, exceed the latest S-100 specs and offer superior performance. Includes true active termination (with half of the termination load at each end of every buss line), grounded Faraday shield between all buss signal lines to minimize crosstalk, and edge connectors included for all slots. All sizes fit Godbout, Vector, TEI, IMSAI, and similar enclosures.

These high quality motherboards are a welcome addition to any system — or the start of a great one.

2S "Interfacer" S-100 I/O board

$189 unkit, $249 assm, $324 CSC

Dual serial port with 2 full duplex parallel ports for RS-232 handshake; EIA232C line drivers and receivers (1488, 1489) along with current loop (20 mA) and TTL signals on both ports. On-board crystal controlled timebase with independently selectable Baud rate generators for each port (up to 19.2 KBaud). Hardware UARTs don't tie up the CPU. And, there's much more . . . this is a no-excuses serial board that does things the others only dream about.

NEW! 3P+S "Interfacer II" S-100 I/O board

$189 unkit, $249 assm, $324 CSC

Incorporates 1 channel of RS-232 serial I/O (with **all** the features of a port from the 2S "Interfacer", including handshaking), along with 3 full duplex parallel ports. The parallel section uses LSTTL octal latches for latched input and output data with 24 mA drive current, attention/enable/and strobe bits for each parallel port (with selectable polarity), interrupts for each input port, and separate 25 pin connectors with power for each channel along with a status port for interrupt mask and port status. All in all, this is an incredibly versatile and flexible board.

2708 S-100 EROM board — $85 unkit

4 independently addressable 4K blocks, with dipswitch selectable jump start built right into the board. Includes all support chips and manual, but does not included EROMs.

Active Terminator Board — $34.50 kit

Plugs into any S-100 motherboard (although ours don't need it) to reduce ringing, noise, crosstalk, and other buss-related problems. Here is an upgrade that is simple and effective.

The Godbout Box!

By the time you read this, we will be shipping our industrial-grade enclosure. It's perfectly suited to creating a powerful system based on our line of S-100 boards (or anyone else's, if you're so inclined). It's rack mount or desk mount (with sliders for pulling it out of the rack if desired), neat-looking, heavy duty, and comes with the back panel pre-punched to accept a variety of connectors. Oh yes, and let's not forget the power supply for powering all your boards; it comes with the box, too. **See your computer store for details, or write us direct.**

NEW! "MEMORY MANAGER" S-100 board

$59 kit, $85 assm, $100 CSC

Now you can add bank select and extended addressing to older S-100 machines like the Altair, IMSAI, Sol, Polymorphic, etc. Either use this board with our new extended addressing boards, or retrofit our high density **Econorams** (the ones with phantom or extra qualifier lines) for use with the **Memory Manager Board** to get up to ½ a megabyte of memory space for your computer.

We supply memory

All our **Econoram*** memory is fully static, zips along at 4 MHz with the Z-80 or 5 MHz with the 8085, supports a number of popular busses, is available from us through computer stores world-wide, includes a 1 year limited warranty, and comes in **three** configurations to suit your needs. For lowest cost, choose an **"unkit"** with sockets and bypass caps pre-soldered in place for an easy, one-evening assembly. When you just can't wait to get going, order our **assembled and tested** version. For critical systems, specify boards qualified under our **Certified System Component (CSC)** high-reliability program. These boards are extensively tested, burned in for 200 hours, and are immediately replaced in event of failure within 1 year of invoice date. Refer to chart below for pricing.

Name	Buss & Notes	Unkit	Assm	CSC
8K Econoram IIA	S-100	**$149**	**$179**	**$239**
16K Econoram IV	S-100	**$269**	**$329**	**$429**
16K Econoram VIIA-16	S-100	**$279**	**$339**	**$439**
24K Econoram VIIA-24	S-100	**$398**	**$485**	**$605**
16K Econoram IX	Dig Grp	**$319**	**$379**	n/a
32K Econoram IX	Dig Grp	**$559**	**$639**	n/a
32K Econoram X	S-100	**$529**	**$649**	**$789**
32K Econoram XI	SBC/BLC	n/a	n/a	**$1050**
16K Econoram XII	S-100 (1)	**$329**	**$419**	**$519**
24K Econoram XII	S-100 (1)	**$429**	**$539**	**$649**
32K Econoram XIII	S-100 (2)	**$559**	**$699**	**$849**
16K Econoram XIV	S-100 (3)	**$289**	**$349**	**$448**
16K Econoram XV-16	H8 (4)	**$329**	**$395**	n/a
32K Econoram XV-32	H8 (4)	**$599**	**$729**	n/a
16K Memory Expansion	(5)	**$87.20**	n/a	n/a

16K x 16 or 32K x 8 Econoram XVI — coming soon!

Notes
(1) Bank select board — 2 independent banks addressable on 8K boundaries.
(2) Bank select board — 2 independent banks addressable on 16K boundaries.
(3) Extended addressing (24 address lines). Single block addressable on 4K boundaries.
(4) Bank select option for implementing memory systems greater than 64K.
(5) Chip set expands memory in Radio Shack-80, Apple, and Exidy Sorcerer machines.

*__Econoram__ is a trademark of **Godbout Electronics.**

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Microswitch keyboard, already encoded with upper and lower case ASCII. Silent switches (not reed type). Requires +5 and −12V. With edge connectors; just plug in and go. **Normally $99, but order merchandise worth $50 or more and the keyboard is yours for only $49!**

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✓ Reader Service—see page 227

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		SN7472N	.29		
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SN7401N	.18	SN7474N	.35	SN74161N	.89
SN7402N	.18	SN7475N	.49	SN74162N	1.95
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SN7411N	.25	SN7490N	.45	SN74174N	.89
SN7412N	.25	SN7491N	.59	SN74175N	.79
SN7413N	.40	SN7492N	.43	SN74176N	.79
SN7414N	.70	SN7493N	.43	SN74177N	.79
SN7416N	.25	SN7494N	.65	SN74179N	1.95
SN7417N	.25	SN7495N	.65	SN74180N	.79
SN7420N	.20	SN7496N	.65	SN74181N	1.95
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SN7432N	.25	SN74125N	.49	SN74193N	.79
SN7437N	.25	SN74126N	.49	SN74194N	.89
SN7438N	.25	SN74132N	.75	SN74195N	.69
SN7439N	.25	SN74136N	.75	SN74196N	.89
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SN7446N	.69	SN74148N	1.29	SN74283N	2.25
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SN7454N	.20	SN74155N	.79	SN74368N	.69
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CD4025	.23	CD4066	.79	CD4518	1.29
CD4026	2.25	CD4068	.39	CD4520	1.29
CD4027	.69	CD4069	.45	CD4566	2.25

74C00

74C00	.39			74C163	2.49
74C02	.39			74C164	2.49
74C04	.39	74C85	2.49	74C173	2.60
74C08	.49	74C90	1.95	74C192	2.49
74C10	.39	74C93	1.95	74C193	2.49
74C14	1.95	74C95	1.95	74C195	2.49
74C20	.39	74C107	1.25	74C922	7.95
74C30	.39	74C151	2.90	74C923	6.25
74C42	1.95	74C154	3.00	74C925	8.95
74C48	2.49	74C157	2.15	74C926	8.95
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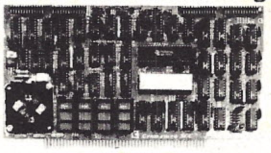
LM320T-15	1.25	NE555V	.39	75452CN	.39
LM320T-18	1.25	NE556N	.99	75453CN	.39
LM320T-24	1.25	NE560B	5.00	75454CN	.39
LM323K-5	5.95	NE561B	5.00	75491CN	.79
LM324N	1.49	NE562B	5.00	75492CN	.89
LM339N	.99	NE565N/H	1.25	75493N	.89
LM340K-5	1.35	NE566CN	1.75	75494CN	.89
LM340K-6	1.35	NE567V/H	.99	RC4136	1.25
LM340K-8	1.35	NE570N	4.95	RC4151	3.95
LM340K-12	1.35	LM703CN/H	.69	RC4194	4.95
LM340K-15	1.35	LM709N/H	.29	RC4195	4.49

74LS00TTL

74LS00	.29			74LS138	.89
74LS01	.29			74LS139	.89
74LS02	.29	74LS47	.89	74LS151	.89
74LS03	.29	74LS51	.29	74LS155	.89
74LS04	.35	74LS54	.29	74LS157	.89
74LS05	.35	74LS55	.29	74LS160	1.15
74LS08	.29	74LS73	.45	74LS161	1.15
74LS09	.35	74LS74	.45	74LS162	1.15
74LS10	.29	74LS75	.59	74LS163	1.15
74LS11	.35	74LS76	.45	74LS164	1.25
74LS13	.59	74LS78	.49	74LS175	.99
74LS14	1.25	74LS83	.89	74LS181	2.49
74LS15	.35	74LS85	1.25	74LS190	1.15
74LS20	.29	74LS86	.45	74LS191	1.15
74LS21	.35	74LS90	.59	74LS192	1.15
74LS22	.35	74LS92	.75	74LS193	1.15
74LS26	.35	74LS93	.75	74LS194	1.15
74LS27	.35	74LS95	.99	74LS195	1.15
74LS28	.35	74LS96	1.15	74LS253	.99
74LS30	.29	74LS107	.45	74LS257	.89
74LS32	.35	74LS109	.45	74LS258	1.75
74LS37	.45	74LS112	.45	74LS260	.69
74LS40	.35	74LS123	1.25	74LS279	.75
74LS42	.89	74LS125	.89	74LS367	.75
		74LS132	.99	74LS368	.75
		74LS136	.49	74LS670	2.49

Cromemco
incorporated

Z80-4MHz Single Card Computer



Cromemco's Single Card Computer is a complete computer which brings the power of the Z-80 and the flexibility of the S-100 bus to the dedicated computer environment.

The card offers 4 MHz operation, 8K bytes of on-board 2716 PROM, and 1K byte of static RAM memory. This stand-alone card also provides an RS-232 (or 20mA current loop) serial interface with programmable baud rates to 76,800, vectored interrupts, 24 bits of bidirectional parallel I/O, and 5 programmable timers. Only a power supply and PROM software are required for operation. The Single Card Computer is assembled and tested (Model SCC-W) for $450. The Monitor and Control BASIC are available in two ROM's (Model MCB-216) for $90.

SCC-W (Assembled) **$450.00**

Processor: 4MHz Z-80
Instruction Set: 158 instructions incl. the 78 instructions of the 8080.
ROM Capacity: 8K Bytes located from address 0000 to 1FFF.
ROM Type: Intel 2716 PROM or equivalent.
RAM Capacity: 1K Bytes located from address 2000 to 23FF
RAM Type: 4045, Static

Serial I/O Ports:
I/O Levels: RS-232 or 20mA current loop
Baud Rates: 110 to 76,800 (software selectable)
Parallel Ports:
Input Port: 24 bits bidirectional
Output Port: 24 bits bidirectional
Input Load: One TTL equivalent
Output Drive: 20 TTL loads
Interval Timers:
Number of timers: 5

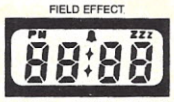
Timer range: 0-16.32 milliseconds (software sel.)
Timer resolution: 64 microseconds
Vectored Interrupts:
No. of restart locations (Z-80 mode): 65,536
General Information:
UART type: 5501 Bus: S-100
Power requirements: +8V at 1.4A, +18V at 70mA, −18V at 25mA
Operating environment: 0-55°C

DISCRETE LEDS

.200" dia.			**.125" dia.**		
XC556R	red	5/$1	XC209R	red	5/$1
XC556G	green	4/$1	XC209G	green	4/$1
XC556Y	yellow	4/$1	XC209Y	yellow	4/$1
XC556C	clear	4/$1			
.200" dia.			**.185" dia.**		
XC22R	red	5/$1	XC526R	red	5/$1
XC22G	green	4/$1	XC526G	green	4/$1
XC22Y	yellow	4/$1	XC526Y	yellow	4/$1
.170" dia.			XC526C	clear	4/$1
MV10B	red	4/$1	**190" dia.**		
.085" dia.			XC111R	red	5/$1
MV50	red	6/$1	XC111G	green	4/$1
			XC111Y	yellow	4/$1
			XC111C	clear	4/$1

INFRA-RED LED
1/4"x1/4"x1/16" flat
5/$1

TIMEX T1001
LIQUID CRYSTAL DISPLAY CLASS II
FIELD EFFECT



4 DIGIT – .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive	**$7.95**
T1001A-Reflective	**8.25**

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.49	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.49	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	.99
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	1.50
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	1.50
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA2023T	2.56	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	.85	CA3401N	.59
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7 seg. C.A. LED driver	1.50

CLOCK CHIPS

MM5309	$4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998A	4.95
CT7001	6.95

MOTOROLA

MC1408L7	$4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$.17	.16	.15	22 pin LP	$ .37	.36	.35
14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61

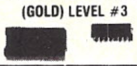
SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin ST	$.27	.25	.24	28 pin ST	$ .99	.90	.81
16 pin ST	.30	.27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin SG	$.30	.27	.24	24 pin SG	$ .70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.65	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3



	1-24	25-49	50-100		1-24	25-49	50-100
8 pin WW	$.39	.38	.31	22 pin WW	$ .95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40
20 pin WW	.85	.79	.72				

1/4 WATT RESISTOR ASSORTMENTS – 5%

		10 OHM	12 OHM	15 OHM	18 OHM	22 OHM		
ASST. 1	5 ea.	27 OHM	33 OHM	39 OHM	47 OHM	56 OHM	50 PCS	$1.75
		68 OHM	82 OHM	100 OHM	120 OHM	150 OHM		
ASST. 2	5 ea.	180 OHM	220 OHM	270 OHM	330 OHM	390 OHM	50 PCS	1.75
		470 OHM	560 OHM	680 OHM	820 OHM	1K		
ASST. 3	5 ea.	1.2K	1.5K	1.8K	2.2K	2.7K	50 PCS	1.75
		3.3K	3.9K	4.7K	5.6K	6.8K		
ASST. 4	5 ea.	8.2K	10K	12K	15K	18K	50 PCS	1.75
		22K	27K	33K	39K	47K		
ASST. 5	5 ea.	56K	68K	82K	100K	120K	50 PCS	1.75
		150K	180K	220K	270K	330K		
ASST. 6	5 ea.	390K	470K	560K	680K	820K	50 PCS	1.75
		1M	1.2M	1.5M	1.8M	2.2M		
ASST. 7	5 ea.	2.7M	3.3M	3.9M	4.7M	5.6M	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

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AY-5-9500	CMOS Clock Generator	4.95
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TL494CN	Switching Regulator	4.49
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11C90	Divide 10/11 Prescaler	19.95
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4N33	Photo-Darlington Opto-Isolator	3.95
MK50240	Top Octave Freq. Generator	17.50
DS0026CH	5Mhz 2-phase MOS clock driver	3.75
TIL308	.27" red num. display w/integ. logic chip	10.95
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit DPM Logic Block (**Special**)	3.95
LD110/111	3½ Digit A/D Converter Set	25.00/set
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XR205	$8.40			XR2242CP	1.50
XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55			XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	3.95
XR567CP	.99	XR2207	3.85	XR4194	4.95
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.95	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.95	XR2212	4.35	XR4739	1.15
XR1489	1.95	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1.00
				1N4003	200 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N3600	50	200m	6/1.00
1N757	9.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N759	12.0	400m	4/1.00	1N4154	35	10m	12/1.00
1N959	8.2	400m	4/1.00	1N4733	5.1	1w	28
1N965	15	400m	4/1.00	1N4734	5.6	1w	28
1N5232	5.6	500m	28	1N4735	6.2	1w	28
1N5234	6.2	500m	28	1N4736	6.8	1w	28
1N5235	6.8	500m	28	1N4738	8.2	1w	28
1N5236	7.5	500m	28	1N4742	12	1w	28
1N5242	12	500m	28	1N4744	15	1w	28
1N5245	15	500m	28	1N1183	50 PIV	35 AMP	1.60
1N456	25	40m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N458	150	7m	6/1.00	1N1185	150 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1186	200 PIV	35 AMP	1.80
1N4001	50 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C36M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369A	4/1.00	MPS3705	5/1.00	2N5087	4/1.00
MPS2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2484	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2906	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2907	5/1.00	2N3711	5/1.00	PN5134	5/1.00
PN2907 Plastic	7/1.00	2N3724A	.65	PN5138	5/1.00
2N2925	5/1.00	2N3725A	1.00	2N5139	5/1.00
MJE2955	1.25	2N3772	2.25	2N5210	5/1.00
2N3053	2/1.00	2N3823	1.00	2N5449	3/1.00
		2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100+		1-9	10-99	100+
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/35V	.35	.31	.27
.22/35V	.28	.23	.17	3.3/25V	.35	.31	.27
.33/35V	.28	.23	.17	4.7/25V	.33	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.49	.45	.35
.68/35V	.28	.23	.17	15/25V	.75	.68	.59
1.0/35V	.28	.23	.17	22/6V	.75	.60	.50
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				**Radial Lead**			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
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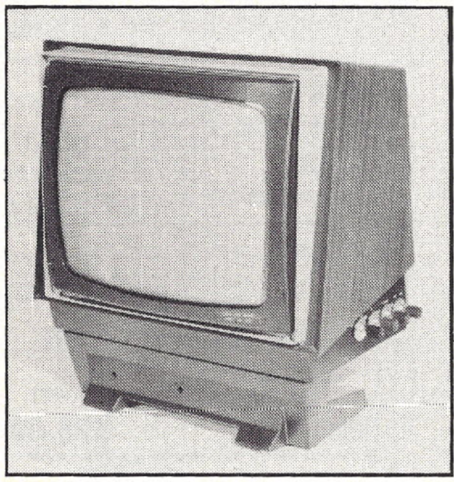

MONITORS

12" black & white monitor. Wide band, will display 80 x 24 char. 10K or 75Ω input impedance, composite video input. Transformer power supply.
Shpt. Wt. 30#
Price: $45.00 ea.
Used with all computers such as: TRS-80, Apple, and many others.

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KEYBOARDS

51 key typewriter style keyboard, with case, not encoded. Single contact keys
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5' RG/59U cable with PL259 connector on one end.
Price: $1.00 ea. 6/$5.00

24" RG/59U cable with PL 259 connector on one end, BNC on other end.
Price: $1.00 ea. 6/$5.00

ASCII KEYBOARD

61 key 7 bit plus strob… Positive logic generates all 1… plus all 32 function code… …olts. With data
Shpt. Wt. …
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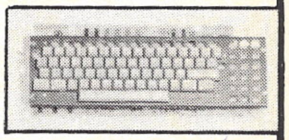

MEMORY CHIP

Static Ram 1K x 4 single 5V power supply, single phase TTL level clock, four chip select inputs with data sheets included
Price: $3.50 ea. or 15/$40.00

CASSETTE DECK

Standard Phillips type cassette no capstan, reel to reel drive with tachometer control, rewind 300 ft. tape in 60 sec. BOT and EOT sense, also cassette in, door closed and broken tape indication.
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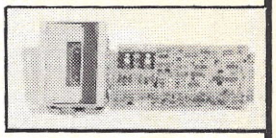
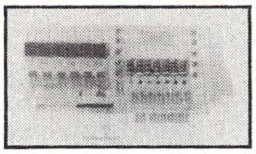
Price: $40.00 ea.



SPECIAL

Microprocessor Chips #6502
Price: $6.00 ea. or 2/$10.00



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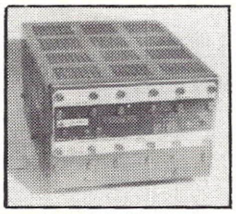
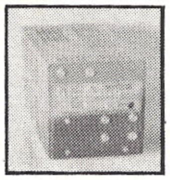
6 digit numeric display boards with 6 FND 507. Common anode displays and 10 red LED's. With drivers & logic for multiplexed operation.
Price: $5.00 ea. or 6/$25.00





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Reader Service—see page 227


COMPUCRUISE
Put a computer in your car, which gives you the most effective and functional cruise control ever designed, plus complete trip computing, fuel management systems, and a remarkable accurate quartz crystal time system.
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FLOPPY DISK STORAGE BINDER
This black vinyl three-ring binder comes with ten transparent plastic sleeves which accommodate either twenty, five-inch or ten, eight-inch floppy disks. The plastic sleeves may be ordered separately and added as needed. A contents file is included with each sleeve for easy identification and organizing. Binder & 10 holders $14.95 Part No. B800; Extra holders 95¢ each. Part No. 800
OPTO-ISOLATED PARALLEL INPUT BOARD FOR APPLE II
There are 8 inputs that can be driven from TTL logic or any 5 volt source. The circuit board can be plugged into any of the 8 sockets of your Apple II. It has a 16 pin socket for standard dip ribbon cable connection.
Board only $15.00. Part No. 120, with parts $69.95. Part No. 120A.
TIDMA
• Tape Interface Direct Memory Access • Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate • S-100 bus compatible • Board only $35.00 Part No. 112, with parts $110 Part No. 112A
SYSTEM MONITOR
8080, 8085, or Z-80 System monitor for use with the TIDMA board. There is no need for the front panel. Complete with documentation $12.95.
16K EPROM
Uses 2708 EPROMS, memory speed selection provided, addressable anywhere in 65K of memory, can be shadowed in 4K increments. Board only $24.95 part no. 7902, with parts less EPROMs $49.95 part no. 7902A.
ASCII KEYBOARD
TTL & DTL compatible • Full 67 key array • Full 128 character ASCII output • Positive logic with outputs resting low • Data Strobe • Five user-definable spare keys • Standard 22 pin dual card edge connector • Requires +5VDC, 325 mA. Assembled & Tested. Cherry Pro Part No. P70-05AB. $119.95.
ASCII KEYBOARD
53 Keys popular ASR-33 format • Rugged G-10 P.C. Board • Tri-mode MOS encoding • Two-Key Rollover • MOS/DTL/TTL Compatible • Upper Case lockout • Data and Strobe inversion option • Three User Definable Keys • Low contact bounce • Selectable Parity • Custom Keycaps • George Risk Model 753. Requires +5, -12 volts. $59.95 Kit.
ASCII TO CORRESPONDENCE CODE CONVERTER
This bidirectional board is a direct replacement for the board inside the Trendata 1000 terminal. The on board connector provides RS-232 serial in and out. Sold only as an assembled and tested unit for $229.95. Part No. TA 1000C
DISK JACKET™
Made from heavy duty .0095 matte plastic with reinforced grommets. The mini-diskette version holds two 5-1/4 inch diskettes and will fit any standard three ring binder. The pockets to the left of the diskette can be used for listing the contents of the disk. Please order only in multitudes of ten. $9.95/10 Pack.
ATARI 800
Computer with 8K $995.00, disk drive $549.00, printer $599.99
VIDEO TERMINAL
16 lines, 64 columns • Upper and lower case • 5x7 dot matrix • Serial RS-232 in and out with TTL parallel keyboard input • On board baud rate generator 75, 110, 150, 300, 600, & 1200 jumper selectable • Memory 1024 characters (7-21L02) • Video processor chip SFF96364 by Neculonic • Control characters (CR, LF, →, ←, ↑, ↓, non destructive cursor, CS, home, CL • White characters on black background or vice-versa • With the addition of a keyboard, video monitor or TV set with TV interface (part no. 107A) and power supply this is a complete stand alone terminal • also S-100 compatible • requires +16, & −16 VDC at 100mA, and 8VDC at 1A. Part No. 1000A $199.95 kit.
RS-232/20mA INTERFACE
This board has two passive, opto-isolated circuits. One converts RS-232 to 20mA, the other converts 20mA to RS-232. All connections go to a 10 pin edge connector. Requires +12 and -12 volts. Board only $9.95, part no. 7901, with parts $14.95 Part No. 7901A.
COMPUCOLOR II
Model 3, 8K $13 95, Model 4, 16K $15 95, Model 5, 32K $18 95. Prices include color monitor, computer, and one disk drive.
PET COMPUTER
With 32K & monitor - $1195. Dual Disk Drive - $1195.
apple II
or
APPLE II PLUS
16K - $995, 32K - $1059, 48K - $1123. Disk & cont. $589
CASSETTE TAPE ERASER
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16K RAMS
For the Apple, TRS-80 or Pet $8 each Part No. 4116/2117.
APPLE II HOBBY/PROTOTYPING CARD
$14.95 Part No. 7907
T.V. INTERFACE
• Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple • Power required is 12 volts AC C.T., or +5 volts DC • Board only $7.60 part No. 107, with parts $13.50 Part No. 107A
PARALLEL TRIAC OUTPUT BOARD FOR APPLE II
This board has 8 triacs capable of switching 110 volt 6 amp loads (660 watts per channel) or a total of 5280 watts. Board only $15.00 Part No. 210, with parts $119.95 Part No. 210A.
To Order:
Mention part no. description, and price. In USA shipping paid by us for orders accompanied by check or money order. We accept C.O.D. orders in the U.S. only, or a VISA or Master Charge no., expiration date, signature, phone no., shipping charges will be added. CA residents add 6.5% for tax. Outside USA add 10% for air mail postage and handling. Payment must be in U.S. dollars. Dealer inquiries invited. 24 hour order line (408) 448-0800
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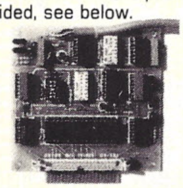
TRS-80 E.S. SERIAL I/O

• Can input into basic • Can use LLIST and LPRINT to output, or output continuously • RS-232 compatible • Can be used with or without the expansion bus • On board switch selectable baud rates of 110, 150, 300, 600, 1200, 2400, parity or no parity odd or even, 5 to 8 data bits, and 1 or 2 stop bits. D.T.R. line • Requires +5, -12 VDC • Board only $19.95 Part No. 8010, with parts $59.95 Part No. 8010A, assembled $79.95 Part No. 8010 C. No connectors provided, see below.

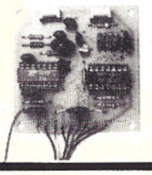


EIA/RS-232 connector Part No. DB25P $6.00, with 9', 8 conductor cable $10.95 Part No. DB25P9.

3' ribbon cable with attached connectors to fit TRS-80 and our serial board $19.95 Part No. 3CAB40.

MODEM

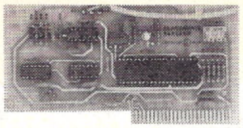
• Type 103 • Full or half duplex • Works up to 300 baud • Originate or Answer • No coils, only low cost components • TTL input and output-serial • Connect 8 Ω speaker and crystal mic. directly to board • Uses XR FSK demodulator • Requires +5 volts • Board only $7.60 Part No. 109, with parts $27.50 Part No. 109A



DISKETTES

Box of 10, 5" $29.95, 8" $39.95.
Plastic box, holds 10 diskettes, 5" - $4.50, 8" - $6.50.

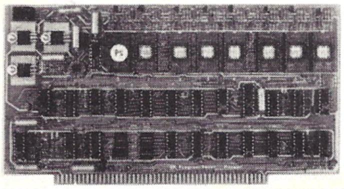
APPLE II SERIAL I/O INTERFACE



Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. • Also watches DTR • Board only $15.00 Part No. 2, with parts $42.00 Part No. 2A, assembled $62.00 Part No. 2C

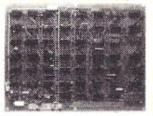
8K EPROM PIICEON

Saves programs on PROM permanently (until erased via UV light) up to 8K bytes. Programs may be directly run from the program saver such as fixed routines or assemblers. • S-100 bus compatible • Room for 8K bytes of EPROM non-volatile memory (2708's). • On-board PROM programming • Address relocation of each 4K of memory to any 4K boundary within 64K • Power on jump and reset jump option for "turnkey" systems and computers without a front panel • Program saver software available • Solder mask both sides • Full silkscreen for easy assembly. Program saver software in 1 2708 EPROM $25. Bare board $35 including custom coil, board with parts but no EPROMS $139, with 4 EPROMS $179, with 8 EPROMS $219.



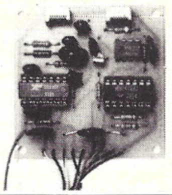
T.V. TYPEWRITER

• Stand alone TVT • 32 char/line, 16 lines, modifications for 64 char/line included • Parallel ASCII (TTL) input • Video output • 1K on board memory • Output for computer controlled curser • Auto scroll • Non-destructive curser • Curser inputs: up, down, left, right, home, EOL, EOS • Scroll up, down • Requires +5 volts at 1.5 amps, and -12 volts at 30 mA • All 7400, TTL chips • Char. gen. 2513 • Upper case only • Board only $39.00 Part No. 106, with parts $145.00 Part No. 106A



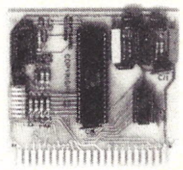
TAPE INTERFACE

• Play and record Kansas City Standard tapes • Converts a low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital in and out are TTL-serial • Output of board connects to mic. in of recorder • Earphone of recorder connects to input on board • No coils • Requires +5 volts, low power drain • Board only $7.60 Part No. 111, with parts $27.50 Part No. 111A



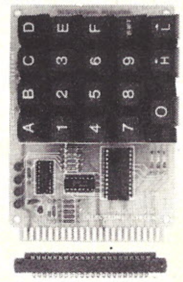
UART & BAUD RATE GENERATOR

• Converts serial to parallel and parallel to serial • Low cost on board baud rate generator • Baud rates: 110, 150, 300, 600, 1200, and 2400 • Low power drain +5 volts and -12 volts required • TTL compatible • All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. • All connections go to a 44 pin gold plated edge connector • Board only $12.00 Part No. 101, with parts $35.00 Part No. 101A, 44 pin edge connector $4.00 Part No. 44P



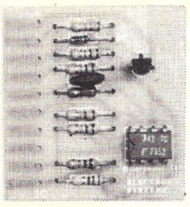
HEX ENCODED KEYBOARD E.S.

This HEX keyboard has 19 keys, 16 encoded with 3 user definable. The encoded TTL outputs, 8-4-2-1 and STROBE are debounced and available in true and complement form. Four onboard LEDs indicate the HEX code generated for each key depression. The board requires a single +5 volt supply. Board only $15.00 Part No. HEX-3, with parts $49.95 Part No. HEX-3A. 44 pin edge connector $4.00 Part No. 44P.



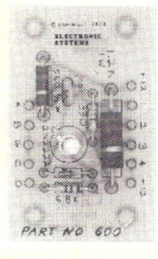
RS-232/ TTL INTERFACE

• Converts TTL to RS-232, and converts RS-232 to TTL • Two separate circuits • Requires -12 and +12 volts • All connections go to a 10 pin gold plated edge connector, kit $ 9.95 Part No. 232A 10 Pin edge connector $3.00 Part No. 10P.



RS-232/TTY INTERFACE

This board has two active circuits, one converts RS-232 to 20mA, and the other converts 20mA to RS-232. Requires +12 and -12 volts. $9.95 Part No. 600A Kit.



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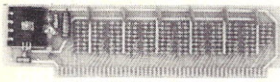
MEM-1A 8Kx8 fully buffered, S-100, uses 2102 type RAMS. PCBD .... $24.95, $168 Kit
QMB-12 MOTHER BOARD, 13 slot, terminated, S-100 board only .... $34.95 $89.95 Kit
CPU-1 8080A Processor board S-100 with 8 level vector interrupt PCBD .. $25.95 $89.95 Kit
RTC-1 Realtime clock board. Two independent interrupts. Software programmable. PCBD .... $25.95, $60.95 Kit
EPM-1 1702A 4K EPROM card PCBD .... $25.95 $49.95 with parts less EPROMS
EPM-2 2708/2716 16K/32K EPROM card PCBD .... $24.95 $49.95 with parts less EPROMS
QMB-9 MOTHER BOARD. Short Version of QMB-12. 9 Slots PCBD .... $30.95 $67.95 Kit
MEM-2 16Kx8 Fully Buffered 2114 Board PCBD .... $25.95, $269.95 Kit

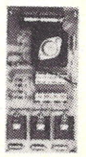
S-100 BUS ACTIVE TERMINATOR

Board only $14.95 Part No. 900, with parts $24.95 Part No. 900A



DC POWER SUPPLY

• Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. • Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps. • Board only $12.50 Part No. 6085, with parts excluding transformers $42.50 Part No. 6085A



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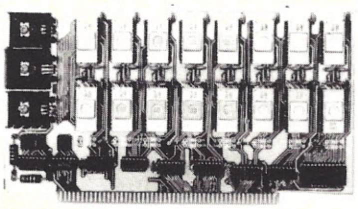
16K EPROM CARD-S 100 BUSS



$59.95 KIT

OUR BEST SELLING KIT!

USES 2708's!

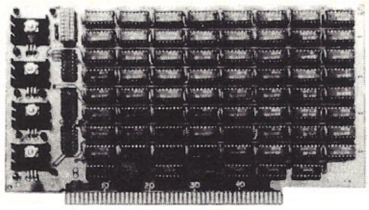
Thousands of personal and business systems around the world use this board with complete satisfaction. Puts 16K of software on line at **ALL TIMES!** Kit features a top quality soldermasked and silk-screened PC board and first run parts and sockets. All parts (except 2708's) are included. Any number of EPROM locations may be disabled to avoid any memory conflicts. Fully buffered and has WAIT STATE capabilities.

OUR 450NS 2708'S ARE $8.95 EA. WITH PURCHASE OF KIT

ASSEMBLED AND FULLY TESTED ADD $25

8K LOW POWER RAM KIT-S 100 BUSS

SALE



PRICE CUT!

$119.50 KIT

(450 NS RAMS!)

Thousands of computer systems rely on this rugged, work horse, RAM board. Designed for error-free, NO HASSLE, systems use.

KIT FEATURES:

1. Doubled sided PC Board with solder mask and silk screen layout. Gold plated contact fingers.
2. All sockets included.
3. Fully buffered on all address and data lines.
4. Phantom is jumper selectable to pin 67.
5. FOUR 7805 regulators are provided on card.

Blank PC Board w/Documentation **$29.95**
Low Profile Socket Set...**13.50**
Support IC's (TTL & Regulators) **$9.75**
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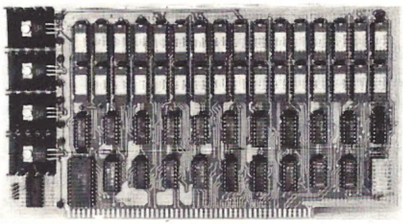
ASSEMBLED AND FULLY BURNED IN ADD $30

16K STATIC RAM KIT-S 100 BUSS

PRICE CUT!

$279 KIT

FOR 250NS ADD $10



FULLY STATIC, AT DYNAMIC PRICES

WHY THE 2114 RAM CHIP?

We feel the 2114 will be the next industry standard RAM chip (like the 2102 was). This means price, availability, and quality will all be good! Next, the 2114 is FULLY STATIC! We feel this is the **ONLY** way to go on the S-100 Buss! We've all heard the HORROR stories about some Dynamic Ram Boards having trouble with DMA and FLOPPY DISC DRIVES. Who needs these kinds of problems? And finally, even among other 4K Static RAM's the 2114 stands out! Not all 4K static Rams are created equal! Some of the other 4K's have **clocked** chip enable lines and various timing windows **just as critical** as Dynamic RAM's. Some of our competitor's 16K boards use these "tricky" devices. But not us! The 2114 is the ONLY logical choice for a trouble-free, straightforward design.

KIT FEATURES:

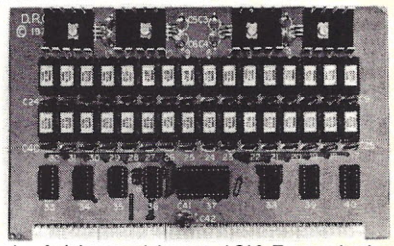
1. Addressable as four separate 4K Blocks.
2. ON BOARD BANK SELECT circuitry. (Cromemco Standard!). Allows up to 512K on line!
3. Uses 2114 (450NS) 4K Static Rams.
4. ON BOARD SELECTABLE WAIT STATES.
5. Double sided PC Board, with solder mask and silk screened layout. Gold plated contact fingers.
6. All address and data lines fully buffered.
7. Kit includes ALL parts and sockets.
8. PHANTOM is jumpered to PIN 67.
9. LOW POWER: under 2 amps TYPICAL from the +8 Volt Buss.
10. Blank PC Board can be populated as any multiple of 4K.

BLANK PC BOARD W/DATA—**$33**
LOW PROFILE SOCKET SET—**$12**
ASSEMBLED & TESTED—**ADD $30**
SUPPORT IC'S & CAPS—**$19.95**

16K STATIC RAM SS-50 BUSS

PRICE CUT!

$275 KIT



FULLY STATIC AT DYNAMIC PRICES

FOR SWTPC 6800 BUSS!

ASSEMBLED AND TESTED - $30

KIT FEATURES:

1. Addressable on 16K Boundaries
2. Uses 2114 Static Ram
3. Runs at Full Speed
4. Double sided PC Board. Solder mask and silk screened layout. Gold fingers.
5. All Parts and Sockets included
6. Low Power: Under 2 Amps Typical

BLANK PC BOARD—**$33**
COMPLETE SOCKET SET—**$12**
SUPPORT IC'S AND CAPS—**$19.95**

S-100 Z80 CPU CARD

ASSEMBLED AND TESTED! READY TO USE! Over 3 years of design efforts were required to produce a **TRUE** S-100 Z80 CPU at a genuinely bargain price! **4 MHZ! $159.95**

FEATURES:

* 2 or 4 MHZ Operation.
* Generates MWRITE, so no front panel required.
* Jump on reset capability
* 8080 Signals emulated for S-100 compatability.
* Top Quality PCB, Silk Screened, Solder Masked, Gold Plated Contact Fingers.

Perfect For OEM's

LOW POWER - 250NS 2114 RAM SALE!

4K STATIC RAM'S. MAJOR BRAND, NEW PARTS. These are the most sought after 2114's, LOW POWER and 250NS FAST.

SPECIAL SALE: $7.50 ea. or 8 For $55
(We reserve the right to limit quantities.)

PROC. TECH. QUITS THE MICROPROCESSOR BUSINESS!
FACTORY CLOSE OUT - SPECIAL PURCHASE!
#16KRA

16K S-100 Dynamic Ram Board - $149.95

ORIGINALLY PRICED AT $429 each!

We purchased the remaining inventory of PT's popular 16K Ram Board when they recently closed their plant. Don't miss the boat! These are brand new, fully tested, ASSEMBLED and ready to go. All are sold with our standard 90 day limited warranty!!

72 Page Full Manual, Included Free!

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(OF TEXAS)

P.O. Box 401565 • GARLAND, TEXAS 75040 • (214) 494-1505

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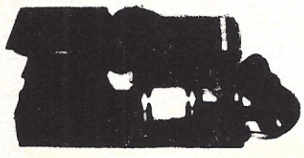
TEST EQUIPMENT
CONNECTORS-WIRE

WALLEN

ELECTRONICS CO. INC. Tel: (617) 588-6440-6441
108 SAWTELL AVE., BROCKTON, MA. 02402



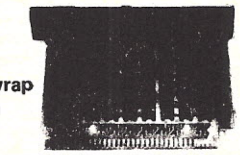
POWER SUPPLIES

REGULATED
COMPUTER

Ideal for micro and mini computers. These units have been removed from equipment, checked out and guaranteed. 5 volts @ 8 amps + 12 volts. 2 amps + 6 volts @ 75 MA. Power supply has a 3-wire line cord and fused. Dimensions: 10½"x5½"x4½". Shipping weight: 16 lbs.

37.50
2 FOR 70.00

WIRE WRAP BOARDS



These boards are pre-wired and removed from equipment. Easy to unwrap for setting up your own board, contains mostly 14-pin IC sockets with individual pin connections. Each board has VCC and ground planes.

Reduced prices

Smaller board measures 6½"x6" and has 40 to 50 sockets. ~~Price $11.00 ea. 2/$20.00~~ $7.50 ea.2/$14.00

Larger board measures 13½"x6" and has 75 to 100 sockets. ~~Price $17.50 ea. 2/$33.00~~ $12.50 ea.2/$23.00

DIABLO SYSTEM DISC DRIVE

SERIES 40 MODEL 43 100 tracks per inch, total capacity of 50 megabits, w/Model 429 power supply, sector counter, 24 sectors, 1 fixed disc, 1 removable disc, average access time 38 ms, PPM: 2400, dimensions: 10 5/16" high, fits in standard rack, equipped with full extension slides, excellent used condition. Shipped freight collect.

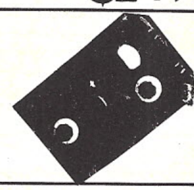
$2495

FM SIGNAL GENERATOR

MEASUREMENTS MODEL 560 FM

Frequency 25 mhz to 80 mhz and 130-175 mhz. Dimensions: 10"x10"x16", weight: 16 lbs. Shipped freight collect. Used. Checked out and operating.

$289



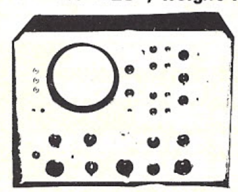
TRANSFORMERS ISOLATION STEP-DOWN TYPE

Primary: 230/115V, 50/60 CPS, Secondary: VA output 250V. **$13.95** EACH

HEWLETT-PACKARD
Model 175A

OSCILLOSCOPES

These scopes have a 50 Mhz bandwidth and have 2 plug-ins, a 1781B Delay generator and a model 1755A Dual trace vertical amplifier. Dimensions: 13"x17"x25", weight 71 lbs. shipped freight collect. 5" scope. Used. Checked out and operating.



$339

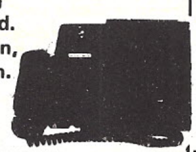
I.C.'s

7444	.45	74H72J	.45
7450	.23	74H72N	.30
7453	.23	74H73N	.40
7460	.23	74H76N	.45
7470	.25	74H87N	1.30
7482	.50	74H101J	.65
7490	.35	74H103J	.50
7491	.65	74H108J	.50
74104	.30	74H50	.23
74111	.35	74H40	.23
74121	.30	74H51	.23
74122	.45	74H21	.23
74142	.90	74H30	.23
74145	.45	74SO9	.23
74156	.35	74S134	.25
74180	.45	74S135	.45
74198	1.45	75150	.85
74249	.45	75154	1.25
74265	.35	LM101H	.75
74HO5N	.25	LM318H	1.25
74H15N	.40	NE531T	.80
74H22J	.30	NE565A	.75
74H60N	.23	LM556CN	.75
74H61J	.30	74H61N	.23
74H71N	.30	CA324G	.50
RC741DP	.18	RC747DP	.30

MEMORY PHONES

By FORD INDUSTRIES, INC.

These units have complete installation and operating instructions w/6-foot cord. Colors: beige, white, green, Used, operating condition.



$89

TRENDLINE PHONES

Mfd. by I.T.T.

Rotary dial. Colors: white, black, red, green. Packaged, has 6-foot cord and installation instructions. Used, operating condition.

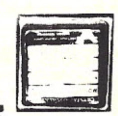
34.50

ROTRON WHISPER FANS

Unused, Model Rotron MU 3A1, 230V, AC, 14 watts, 50/60 hz, guaranteed, 4½"x4½"x1½". **$8.95**

CRYSTAL OSCILLATORS

Vectron type CO-231T crystal freq. 4.9152, MHZ w/tuning option for accuracy of .0001%. 1½"x 1½"x½".R.F.E. **13.95**



INCANDESCENT READOUT ASSEMBLY

Readouts assembled of the 710 series modules. Character 1" high w/lamps. Type No. 344. By Dialco.

1.50 EACH

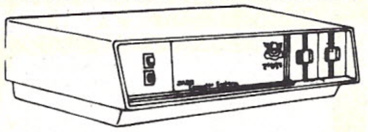
I.C. SOCKETS

14-PIN Wire Wrap	.30
14-PIN Low Profile	.15
28-PIN Low Profile	.35
40-PIN Low Profile	.50

Minimum order $25.00. Items offered subject to prior sale. FOB, Brockton, Mass. Money order or check w/order. Shipping and handling add 5%. Shipments by parcel post or UPS. No CODs. Mass. residents add 5% sales tax.

JADE Computer Products

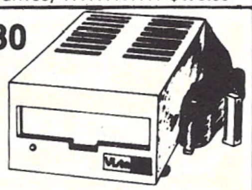
JADE'S NEW MAINFRAME
THE PIGGY IS HERE!



This sleak new mainframe is beautifully designed around JADE'S six slot **ISO-BUS** motherboard and an 18 amp power supply with provisions for up to 3 mini-floppy drives. This is a practical, state-of-the-art design whose looks just can't be beat!
ENS-106320 (without drives) **$475.00**

VISTA V80

TRS-80 MINI-DISK SYSTEM



The **V80** out-performs standard Radio Shack drives!--23% more storage capacity, 8 times faster access time, more reliable, and much less expensive. Includes disk drive, power supply, regulator board, and case. **MSM-358000 $395.00**
Interface cable for V80 **WCA-3421** **$24.95**

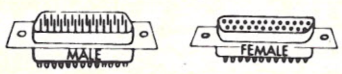
DISKETTE SPECIAL

5.25" SOFT, 10, OR 16 SECTOR
10 for $29.95
8" SOFT SECTOR IBM COMPATIBLE
10 for $34.95

S-100 CONNECTOR SALE

100 PIN IMSAI TYPE SOLDER-TAIL CONNECTOR

6 for $17.50 **12 for $29.95**

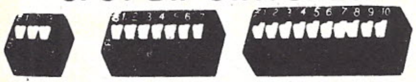


RS-232 SET SPECIAL $6.50

DB-25S, DB-25P, DB-25 COVER

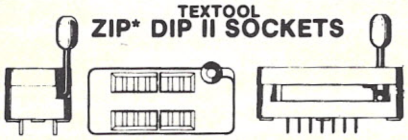
DB-25S (FEMALE) **$3.65**
DB-25P (MALE) **$3.15**
DB-25C (COVER) **$1.50**

SPST DIP SWITCHES



PART NUMBER	NUMBER OF SWITCHES	PRICE
SWD-103	3	$1.18
SWD-104	4	$1.20
SWD-105	5	$1.24
SWD-106	6	$1.28
SWD-107	7	$1.30
SWD-108	8	$1.34
SWD-109	9	$1.36
SWD-110	10	$1.38

TEXTOOL
ZIP* DIP II SOCKETS



16 PIN ZIP* DIP II ... **$5.50**
24 PIN ZIP* DIP II ... **$7.50**
40 PIN ZIP* DIP II .. **$10.25**
*** ZERO INSERTION PRESSURE**

JADE'S NEW INTELLIGENT CONTROLLER
THE DOUBLE-D

Read/write in single or **double density.**
8" or 5¼" drives.
CP/M compatible in either single or double density.
On-board Z-80 CPU allows universal compatibility.
Programmed data transfer. **No DMA.**
Controls up to 8 drives.
Software selectable density.

Our new controller utilizes the IBM standard formats for proven reliability. Data recovery is enhanced through the use of a phase-locked-loop data separation circuit and write precompensation. Single and double density disk drives can be mixed in the same system.

KIT **$285.00**
ASSEMBLED & TESTED **$349.00**
BARE BOARD with MANUAL **$55.00**
MANUAL **$10.00**

SD SYSTEMS
VERSA-FLOPPY

KIT **$159.95**
ASSEMBLED & TESTED **$239.00**

TARBELL
FLOPPY DISK INTERFACE

JADE KIT **$190.00**
ASSEMBLED & TESTED **$260.00**

FLOPPY DISK SPECIAL

TWO SIEMENS 8" DISK DRIVES
JADE DOUBLE-D CONTROLLER KIT
POWER SUPPLY FOR DRIVES
CP/M OPERATING SYSTEM W/BASIC-E
BOX OF 10 DOUBLE DENSITY DISKS
INTERFACE CABLES---A $1594.95 VALUE.
JADE SPECIAL $1225.00

FLOPPY DISK DRIVES

NEW BASF MINI-FLOPPY **$319.95**
Shugart SA400 compatible but only two-thirds the size! 40 track, double density 5¼" drive. Very low power consumption!

MPI B51 5¼" DRIVE **$295.00**
Single or double density, up to 40 tracks, track-to-track access time of 5ms, Shugart SA400 compatible.

MPI B52 5¼" DRIVE **$450.00**
Double-sided version of MPI B51.

SHUGART SA400 5¼" DRIVE **$325.00**
Single density, 35 track.

SIEMENS FDD100-8 8" DRIVE **$495.00**
Certfied double density Shugart 801R replacement.Runs much cooler and quieter.

SIEMENS FDD200-8 8" DRIVE **$575.00**
Double-sided, double density version of FDD100-8.

SHUGART 801R 8" DRIVE **$575.00**
Hard or soft sectored, 400K byte drive.

PERSCI 277 DOUBLE 8" DRIVE **$1595.00**
Limited quantity with slim line case & power supply.

POWER SUPPLIES

For a single 5¼" disk drive.
PSD-249A **$52.00**

For a single 8" disk drive.
PSD-205A **$89.95**

For two 8" disk drives.
PSD-206A **$125.00**

For Rockwell AIM-65.
PSX-030A **$59.95**

For KIM-1 or SYM-1.
PSX-020A **$59.95**

CP/M 2.0

Digital Research has done it again! This new release of their industry standard disk operating system is bound to be an even bigger hit than the original version. All of the fundamental file-size restrictions of release 1 have been eliminated, while maintaining full compatibility with the earlier versions. This new release can be field-configured by the user for a single mini-disk up through a multiple drive hard-disk system with 128 megabyte capacity. Field configuration can be accomplished easily through use of the Macro Library (DISKDEF) provided with CP/M 2.0.

A powerful operating system for only ... **$150.00**

INTEGRAL DATA SYSTEMS MODEL 440 PRINTER
THE PAPER TIGER

Up to 198 CPS
1.75 to 9.5 inch adjustable tractor feed.
Parallel and serial interface.
98 character ASCII set
132 columns- 6 or 8 lines/inch
Eight software selectable character sizes.
110, 300, 600, 1200 baud.

PRM-33440 .... **$995.00**
For the **Graphics Option** with **2K Buffer** add $199.00

JADE JP80-T PRINTER
HARD COPY......EASY PRICE!

JADE is proud to announce the low-cost solution to your hard copy needs. The JADE JP80-T printer is a high quality 80 column dot matrix printer with an adjustable width tractor feed mechanism. We are certain that you can not get a better printer in this price range!
FAST-150 cps print speed, 80 columns per line.
VERSATILE-adjustable tractor feed 2" to 10".
Upper and lower case 96 character ASCII set.
5 X 7 dot matrix with software selectable character widths.
Centronics-type parallel interface.
Interface/cables available for most popular microcomputers.
PRM-27081 .... **$749.95**

CENTRONICS 730 PRINTER
THE ANY-PAPER PRINTER

This printer can use roll paper, fanfold paper, or single sheets because it is equipped with both friction feed and pin feed mechanisms.
RS232 or parallel interface.
96 ASCII character set, upper and lower case.
80 characters per line, 7 X 7 dot matrix.
50 cps print speed.
Weighs less than 10 pounds!
PRM-15730 .... **$950.00**

EXIDY SORCERER

FREE 12 INCH B & W MONITOR WITH EVERY 16K SORCERER

Flexibility is the key. The Sorcerer Computer gives you the flexibility of using ready-to-run, pre-packaged programs or doing your won thing and personalizing the programs for yourself. Whic ever you choose. The Sorcerer is the personal computer that speaks your language.

The Sorcerer also provides full graphics capabilities. Each character formed by an 8 x 8 dot cell, can be programmed as a graphic symbol set. High resolution (512 x 240 addressable points) gives a total of 122,880 locations for super animation and extremely light plotting curves. The alphanumeric set gives 64 x 30 characters on the video screen.

With 16K of memory **$82.00**

LEEDEX MONITOR $139.00

- **12" Black and White**
- **12 MHZ Bandwidth**
- **Handsome Plastic Case**

JADE DISK CABLES

MINI-DISK CABLE KIT--Connects two 5¼" mini-floppies to your disk controller board and power supply. Includes 5' signal cable with three 34 pin edge connectors, plus power supply connectors and cables. **WCA-3431K** **$34.95**

SIGNAL CABLE ONLY--Connects one 5¼" drive to edge type controller card. **WCA-3421A** .. **$24.95**
For two 5¼" drives. **WCA-3431A** **$29.95**

8" DISK CABLE KIT--Connects two 8" disk drives to edge type controller card such as the **Versafloppy** and **Double D**. Includes 5' signal cable with three 50 pin edge connectors, plus power supply cables and connectors. **WCA-5031K** **$38.45**
8" DISK CABLE KIT--Same as WCA-5031K except controller end of signal cable has a pin type connector such as the **Tarbell** controller.
WCA-5032K **$38.95**

J6

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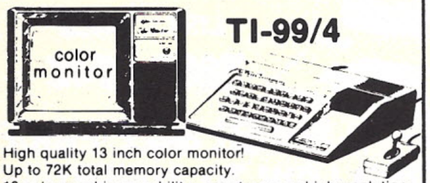
800-262-1710 INSIDE CALIFORNIA

TEXAS INSTRUMENTS

TI-99/4



High quality 13 inch color monitor!
Up to 72K total memory capacity.
16-color graphics capability - easy to access high resolution graphics have special features that let you define your own characters, charts, graphs, etc.
Music and sound effects - build three-note chords and adjust frequency, duration and volume quickly and simply. Five full octaves. Built-in equation calculator—Unique convenience feature helps you find quick solutions to everyday math problems, as well as complex scientific calculations.
Programs are sealed securely in SOLID STATE SOFTWARE COMMAND MODULES. These ROM pack acctually add memory to the TI-99/4 so that the console's memory can be utilized for user input. **SYO-8994A $1150.00**

SD SYSTEMS
Z-80 STARTER KIT

Based on the powerful Z-80 CPU, this kit is an ideal introduction to microprocessors. It has an on-board keyboard and display, plus cassette tape interface, and expansion provisions for two S-100 connectors. This "Do-it-all-Board" will also program the 2716 2K

Kit $249.95
Assembled and tested $439.00

SD SYSTEMS
SBC-100

An S 100 single board computer. Z 80 CPU with 1024 bytes of RAM 8-32K bytes of PROM Serial I/O port.

Kit $239.95
Assembled $369.95

Solid State Music
I/O 4

2 Serial and 2 Parallel I/O.
Ports S 100 with full hand shaking.

JADE Kit $149.95
Assembled $199.95
Bare Board $29.95

PARALLEL/SERIAL INTERFACE

S-100 compatible, 2 serial I/O ports, 1 parallel I/O.

Kit $124.95
Assembled & Tested $179.95
Bare Board W/ Manual $30.00

PROTO BOARD

Includes gold plated fingers. S-100 size, holds 72-16 pin dips, accomodates all 8 thru 40 pin dip packages. Reg. 19.95
TSXA-140B $16.95

SYM-1

6502- Based single board computer with keyboard/display. KIM 1 hardware compatible, complete documentation.
SYM-1 CPK-5002A $245.00
SYM-1 CASE, ENX-000005 .... $39.95

JADE'S NEW MOTHERBOARDS
THE ISO-BUS

The only motherboard availible today that is designed to IEEE S-100 Bus Standards--a unique network theory of design in which each signal line is surrounded by current mirrored ground lines, significantly reducing RF radiation virtually eliminating crosstalk. No need for active termination. The perfect foundation for a 4MHz system.

6-SLOT
BARE BOARD $24.95
KIT $49.95
ASSEMBLED & TESTED $59.95

12-SLOT
BARE BOARD $39.95
KIT $89.95
ASSEMBLED & TESTED $99.95

18-SLOT
BARE BOARD $59.95
KIT $129.95
ASSEMBLED & TESTED $149.95

JADE
MEMORY EXPANSION KITS
FOR
TRS-80 APPLE EXIDY

Everything you need to add 16K of memory to your computer. Your kit comes neatly packaged with easy to follow instructions. In just minutes your computer is ready to tackle more advanced software.

$82.00

THE BIG Z
THE NEW Z-80 CPU BOARD FROM JADE

Features include ● S-100 Compatible available in 2MHz or 4MHz versions. ●On-board 2708, 2716, or 2532 EPROM can be addressed on any 1K, 2K or 4K boundary with power-on jump to EPROM. ● On-board EPROM may be used in SHADOW mode, allowing full 64K RAM to be used. ● Automatic MWRITE generation in front panel is not used. ●On-board USART for synchronous or asynchronous R232 operation (on-board baud rate generator). ●Reverse channel capability on USART allows use with buffered peripherals or devices with not-ready signal.

2MHz Kit: CPU-30200K. 2lbs $149.95
Assembled and Tested CPU 30200A 2lbs. $199.95
4MHz Kit: CPU-3020 1K. 2 lbs. $159.95
Assembled and Tested CPU-30201A. 2lbs. $209.95

MICROPROCESSORS	
F8	$16.95
Z80 (2MHz)	$10.95
Z80A (4MHz)	$14.95
CDP1802CD	$24.95
6502	$11.95
6800	$12.50
6802	$20.00
8008-1	$15.95
8035	$24.00
8035-8	$24.00
8080-A	$10.00
8085	$23.00
TMS9900TL	$49.95
8080A SUPPORT DEVICES	
8212	$5.00
8214	$4.65
8216	$2.95
8224 (2MHz)	$4.30
8226	$2.75
8228	$6.40
8238	$6.40
8243	$8.00
8251	$7.50
8253	$20.00
8255	$6.40
8257	$19.95
8259	$19.95
8275	$69.95
8279	$17.70
USRT	
S2350	$10.95
UARTS	
AY5-1013A	$5.25
AY5-1014A	$8.25
TR1602B	$5.25
TMS6011	$5.95
IM6403	$9.00
BAUD RATE GENERATORS	
MC14411	$10.00
14411 Crystal	$4.95

6800 PRODUCT	
6821P	$5.25
6828P	$12.00
6834P	$16.95
6850P	$4.80
6852P	$7.50
6860P	$9.25
6862P	$12.00
6875L	$7.30
6880P	$2.50
CHARACTER GENERATORS	
2513 Upper	$7.95
2513 Lower	$6.75
2513 Upper (5 volt)	9.75
2513 Lower (5 volt)	$13.00
MCM6571 up scan	$13.00
MCM6571A down scan	$10.95
PROMS	
1702A	$5.00
2708	$12.95
2716	$49.00
2716 (5v)	$49.00
2758 (5v)	$30.00
DYNAMIC RAMS	
4116/416D (200ns)	$12.95
2104/4096	$4.75
2107B-4	$3.95
TMS4027/4096	$4.75
STATIC RAMS	
21L02 (450ns)	$1.50
21L02 (250ns)	$1.75
2101-1	$2.95
2111-1	$3.25
2112-1	$2.95
2114L (450ns)	$8.00
2114L (300ns)	$9.00
TMS4044 (450ns)	$8.00
TMS4044 (300ns)	$9.95
410D (200ns)	$9.95
4200A (200ns)	$9.95
MM5257 (450ns)	$8.00
MM5257 (300ns)	$9.95

JADE maintains an inventory of over 4000 line items, for price and delivery on items not listed (including hard to find 74LS devices!) please give us a call.

JADE
Computer Products

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213-679-3313

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WRITE FOR OUR FREE 1979 CATALOG
FOR CUSTOMER SERVICE OR TECHNICAL INQUIRIES
CALL 213-679-3317

TERMS OF SALE: Cash, checks, money orders, and credit cards accepted. **Minimum order $10.00.** California residents add 6% sales tax. Minimum shipping and handling charge $2.50. Prices are for U.S. and Canadian delivery only and are subject to change without notice. For export prices and information send for a ***JADE INTERNATIONAL CATALOG.***

ROCKWELL AIM-65
THE HEAD-START IN MICROCOMPUTERS

A KIM-1 COMPATIBLE MACHINE WITH ON-BOARD PRINTER AND A REAL KEYBOARD!

AIM-65 w/1K of RAM $375.00
AIM-65 w/4K of RAM $450.00
8K BASIC in ROM $100.00
4K Assembler/Editor $80.00
Power Supply $59.95
Case of AIM-65 $49.95

Special Package Price $599.00
4K AIM-65, 8K BASIC ROM, Power Supply, and Case.

SD SYSTEMS
EXPANDORAM
Expandable to 32K or 64K

EXPANDO-32K KITS

Uses 4115 (8K X 1,250ns) Dynamic RAMs. Can be expanded in 8K increments up to 32K

8K $159.95 **24K $249.95**
16K $199.95 **32K $299.95**

EXPANDO-64K KITS

Uses 4116 (16K X 1, 200ns) Dynamic RAMs. Can be expanded up to 64K in 16K increments.

16K $249.95 **48K $469.95**
32K $369.95 **64K $569.95**

STATIC RAM BOARDS

8K 2MHz KIT $125.95
8K 2MHz ASSEMBLED & TESTED $175.00
8K 4MHz KIT $149.95
8K 4MHz ASSEMBLED & TESTED $180.00
8K BARE BOARD & MANUAL $25.00
16K 2MHz KIT $250.00
16K 2MHz ASSEMBLED & TESTED $325.00
16K 4MHz KIT $285.00
16K 4MHz ASSEMBLED & TESTED $350.00
16K BARE BOARD & MANUAL $35.00
32K 2MHz KIT $539.95
32K 2MHz ASSEMBLED & TESTED $650.00
32K 4MHz KIT $619.95
32K 4MHz ASSEMBLED & TESTED $675.00

SD SYSTEMS
VDB-8024

An **80 by 24** I/O mapped video board for S-100 systems. An on-board Z-80 processor is used to control all functions. A total of 256 user-programmable characters are available, including 128 characters that are supplied with the board. **This is virtually a stand-alone terminal!**

KIT $319.95
ASSEMBLED AND TESTED $469.95

JADE VB-1B

This 64 by 16 memory-mapped video board is ideal for use with word processing software such as the Electric Pencil.

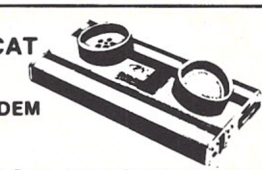
KIT $127.50
ASSEMBLED AND TESTED $169.95
BARE BOARD/MANUAL $35.00

VECTOR GRAPHICS
FLASHWRITER II

The ultimate memory-mapped 80 character by 24 line video board, the Vector Graphics FWII has many advanced features: Onboard parallel keyboard port, Power-on jump circuit, 8 X 10 dot character matrix, and the optional ability to program your own characters and/or graphics symbols. this is THE perfect board for text editing systems.

ASSEMBLED AND TESTED $320.00

NOVATION CAT
ACOUSTIC MODEM



Features include 300 Baud Answer/Originate, Bell 103.
Assembled and Tested $189.00

DIODES/ZENERS

QTY.				
	1N914	100v	10mA	.05
	1N4005	600v	1A	.08
	1N4007	1000v	1A	.15
	1N4148	75v	10mA	.05
	1N4733	5.1v	1 W Zener	.25
	1N4749	24v	1W	.25
	1N753A	6.2v	500 mW Zener	.25
	1N758A	10v	"	.25
	1N759A	12v	"	.25
	1N5243	13v	"	.25
	1N5244B	14v	"	.25
	1N5245B	15v	"	.25
	1N5349	12v	3W	.25

SOCKETS/BRIDGES

QTY.					
	8-pin	pcb	.16	ww	.35
	14-pin	pcb	.20	ww	.40
	16-pin	pcb	.25	ww	.45
	18-pin	pcb	.30	ww	.95
	20-pin	pcb	.35	ww	1.05
	22-pin	pcb	.40	ww	1.15
	24-pin	pcb	.45	ww	1.25
	28-pin	pcb	.50	ww	1.35
	40-pin	pcb	.55	ww	1.45
	Molex pins	.01	To-3 Sockets		.35
	2 Amp Bridge		100-prv		.95
	25 Amp Bridge		200-prv		1.50

TRANSISTORS, LEDS, etc.

QTY.			
	2N2222M	(2N2222 Plastic .10)	.15
	2N2222A		.19
	2N2907A	PNP	.19
	2N3906	PNP (Plastic)	.19
	2N3904	NPN (Plastic)	.19
	2N3054	NPN	.55
	2N3055	NPN 15A 60v	.60
	T1P125	PNP Darlington	1.95
	LED Green,	Red, Clear, Yellow	.19
	D.L.747	7 seg 5/8" High com-anode	1.95
	MAN72	7 seg com-anode (Red)	1.25
	MAN3610	7 seg com-anode (Orange)	1.25
	MAN82A	7 seg com-anode (Yellow)	1.25
	MAN74	7 seg com-cathode (Red)	1.50
	FND359	7 seg com-cathode (Red)	1.25

9000 SERIES

QTY.			QTY.		
	9301	.85		9322	.65
	9309	.50		9601	.30
	9316	1.25		9602	.45

MICRO's, RAMS, CPU's, E-PROMS

QTY.		
	8T13	2.50
	8T23	2.50
	8T24	3.00
	8T97	1.75
	74S188	3.00
	1488	1.25
	1489	1.25
	1702A	6.50
	AM 9050	5.00
	ICM 7207	6.95
	ICM 7208	13.95
	MPS 6520	10.00
	MM 5314	4.00
	MM 5316	4.50
	MM 5387	3.50
	MM 5369	2.95
	TR 1602B	3.95
	UPD 414	4.95
	Z 80 A	19.50
	Z 80	14.50
	Z 80 P10	10.50
	2102	1.45
	2102L	1.75
	2107B-4	4.95
	2114	9.50
	2513 Upper or Lower	7.25
	2708	12.50
	2716 D.S.	29.00
	2716 (5v)	69.00
	2758 (5v)	32.95
	3242	10.50
	4116	13.50
	6800	13.95
	6850	7.95
	8080	9.50
	8085	22.50
	8212	3.75
	8214	4.95
	8216	4.50
	8224	5.25
	8228	6.00
	8251	8.50
	8253	18.50
	8255	9.50
	TMS 4044	10.95

– T T L –

8-1-79

QTY.			QTY.			QTY.			QTY.		
	7400	.20		7492	.45		74H10	.35		74LS51	.75
	7401	.20		7493	.35		74H11	.25		74LS74	1.50
	7402	.20		7494	.75		74H15	.45		74LS75	1.20
	7403	.20		7495	.60		74H20	.25		74LS76	.70
	7404	.45		7496	.80		74H21	.25		74LS86	.95
	7405	.35		74100	1.15		74H22	.40		74LS90	.85
	7406	.35		74107	.35		74H30	.30		74LS93	.85
	7407	.55		74121	.45		74H40	.35		74LS96	2.00
	7408	.40		74122	.55		74H50	.30		74LS107	.90
	7409	.25		74123	.55		74H51	.30		74LS109	1.50
	7410	.20		74125	.45		74H52	.20		74LS123	1.95
	7411	.25		74126	.45		74H53	.25		74LS138	2.00
	7412	.25		74132	.75		74H55	.25		74LS151	.95
	7413	.45		74141	.90		74H72	.35		74LS153	1.15
	7414	.95		74145	1.35		74H74	.35		74LS157	1.15
	7416	.25		74150	.85		74H101	.95		74LS160	1.15
	7417	.40		74151	1.15		74H103	.55		74LS164	2.90
	7420	.25		74153	1.15		74H106	1.15		74LS193	2.00
	7426	.25		74154	1.15		74L00	.30		74LS195	1.15
	7427	.25		74156	.70		74L02	.30		74LS244	2.90
	7430	.20		74157	.65		74L03	.35		74LS259	1.50
	7432	.50		74161	.95		74L04	.40		74LS298	1.50
	7437	.20		74163	.85		74L10	.30		74LS367	2.50
	7438	.30		74164	.75		74L20	.45		74LS368	1.25
	7440	.20		74165	1.10		74L30	.55		74LS373	2.50
	7441	1.15		74166	2.25		74L47	1.95		74S00	.60
	7442	.55		74175	.90		74L51	.65		74S02	.45
	7443	.45		74176	.95		74L55	.85		74S03	.35
	7444	.45		74177	1.10		74L72	.65		74S04	.65
	7445	.75		74180	.95		74L73	.70		74S05	.45
	7446	.70		74181	2.25		74L74	.75		74S08	.65
	7447	.70		74182	.75		74L75	1.05		74S10	.45
	7448	.50		74190	1.25		74L85	2.00		74S11	.45
	7450	.25		74191	1.25		74L93	.75		74S20	.35
	7451	.25		74192	.75		74L123	1.95		74S22	.55
	7453	.20		74193	.85		74LS00	.60		74S40	.30
	7454	.25		74194	.95		74LS01	.40		74S50	.30
	7460	.40		74195	.95		74LS02	.55		74S51	.35
	7470	.45		74196	.95		74LS03	.45		74S64	.15
	7472	.40		74197	.95		74LS04	.65		74S74	1.50
	7473	.25		74198	1.45		74LS05	.45		74S112	.60
	7474	.50		74221	2.25		74LS08	.65		74S114	.85
	7475	.35		74298	1.50		74LS09	.45		74S133	.85
	7476	.40		74367	1.35		74LS10	.45		74S140	.75
	7480	.75		75451	.65		74LS11	.45		74S151	.95
	7481	.85		75452	.65		74LS20	.45		74S153	.95
	7482	.95		75491	.65		74LS21	.45		74S157	.98
	7483	.95		75492	.65		74LS22	.45		74S158	.80
	7485	.75		74H00	.20		74LS32	.60		74S194	2.25
	7486	.55		74H01	.30		74LS37	.45		74S196	2.00
	7489	1.05		74H04	.30		74LS38	.65		74S257 (8123)	2.95
	7490	.55		74H05	.25		74LS40	.70		8131	2.75
	7491	.70		74H08	.35		74LS42	1.25			

C MOS

QTY.			QTY.			QTY.			QTY.		
	4000	.20		4018	.75		4037	1.80		4071	.25
	4001	.30		4019	.35		4040	.75		4072	.60
	4002	.25		4020	.85		4041	.69		4081	.30
	4004	3.95		4021	.75		4042	.65		4082	.30
	4006	1.50		4022	.75		4043	.50		4507	.95
	4007	.25		4023	.25		4044	.65		4511	.95
	4008	.75		4024	.75		4046	1.25		4512	1.25
	4009	.35		4025	.25		4047	2.50		4515	2.95
	4010	.35		4026	1.95		4048	1.75		4519	.85
	4011	.35		4027	.35		4049	.65		4522	1.10
	4012	.25		4028	.75		4050	.45		4526	.95
	4013	.40		4029	1.15		4052	.75		4528	1.10
	4014	.75		4030	.30		4053	.95		4529	.95
	4015	.75		4033	1.50		4066	.75		MC14409	14.50
	4016	.35		4034	2.45		4069/74C04	.45		MC14419	4.85
	4017	.75		4035	.75		4070	1.00		74C151	2.50

I²L, LINEARS, REGULATORS, ETC.

QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price
	MCT2	.95		LM320K24	1.65		LM373	3.95
	8038	3.95		LM320T5(7905)	1.65		LM377	3.95
	LM201	.75		LM320T12	1.65		78L05	.75
	LM301	.45		LM320T15	1.65		78L12	.75
	LM308	.65		LM323K	5.95		78L15	.75
	LM309H	.85		LM324	1.25		78M05	.75
	LM309 (340K-5)	1.50		LM339	.75		LM380 (8-14 Pin)	1.19
	LM310	.85		7805 (340T5)	1.15		LM709 (8-14 Pin)	.45
	LM311 (8-14 Pin)	.75		LM340T12	.95		LM711	.45
	LM318	1.50		LM340T15	.95		LM723	.40
	LM320H6	.79		LM340T18	.95		LM725	3.50
	LM320H15	.79		LM340T24	.95		LM739	1.50
	LM320H24	.79		LM340K12	1.25		LM741 (8-14)	.45
	LM320K5	1.65		LM340K15	1.25		LM747	1.10
	LM320K12	1.65		LM340K18	1.25		LM1307	1.75
	LM320K15	1.65		LM340K24	1.25		LM1458	.65
							LM3900	1.50
							NE555	.45
							NE556	.85
							NE565	1.15
							NE566	1.25
							NE567	.95
							TA7205	4.95
							76477	2.95
							95H90	9.95

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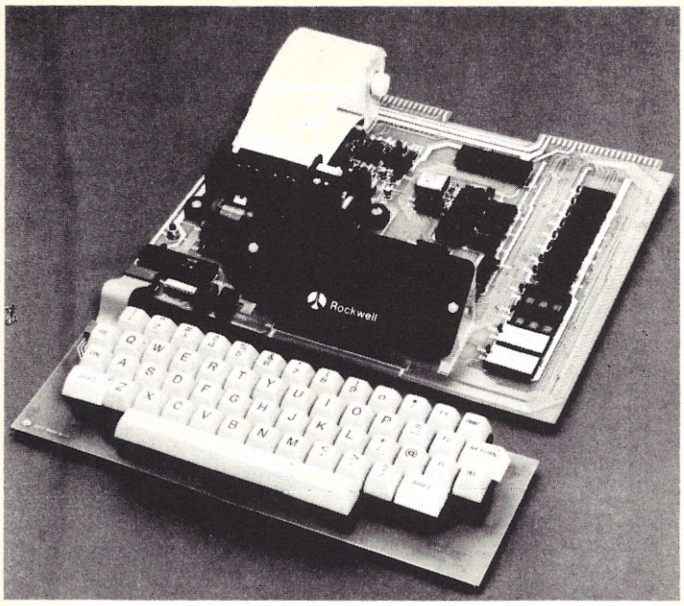
SPECIAL DISCOUNTS

Total Order	Deduct
\$35-\$99	10%
\$100-\$300	15%
\$301-\$1000	20%

AIM 65 BY ROCKWELL INTERNATIONAL



AIM 65 is fully assembled, tested and warranted. With the addition of a low cost, readily available power supply, it's ready to start working for you.

AIM 65 features on-board thermal printer and alphanumeric display, and a terminal-style keyboard. It has an addressing capability up to 65K bytes, and comes with a user-dedicated 1K or 4K RAM. Two installed 4K ROMS hold a powerful Advanced Interface Monitor program, and three spare sockets are included to expand on-board ROM or PROM up to 20K bytes.

An Application Connector provides for attaching a TTY and one or two audio cassette recorders, and gives external access to the user-dedicated general purpose I/O lines.

Also included as standard are a comprehensive AIM 65 User's Manual, a handy pocket reference card, an R6500 Hardware Manual, an R6500 Programming Manual and an AIM 65 schematic.

AIM 65 is packaged on two compact modules. The circuit module is 12 inches wide and 10 inches long, the keyboard module is 12 inches wide and 4 inches long. They are connected by a detachable cable.

THERMAL PRINTER
Most desired feature on low-cost microcomputer systems . . .
- Wide 20-column printout
- Versatile 5 x 7 dot matrix format
- Complete 64-character ASCII alphanumeric format
- Fast 120 lines per minute
- Quite thermal operation
- Proven reliability

FULL-SIZE ALPHANUMERIC KEYBOARD
Provides compatibility with system terminals . . .
- Standard 54 key, terminal-style layout
- 26 alphabetic characters
- 10 numeric characters
- 22 special characters
- 9 control functions
- 3 user-defined functions

TRUE ALPHANUMERIC DISPLAY
Provides legible and lengthy display . . .
- 20 characters wide
- 16-segment characters
- High contrast monolithic characters
- Complete 64-character ASCII alphanumeric format

PROVEN R6500 MICROCOMPUTER SYSTEM DEVICES
Reliable, high performance NMOS technology . . .
- R6502 Central Processing Unit (CPU), operating at 1 MHz. Has 65K address capability, 13 addressing modes and true index capability. Simple but powerful 56 instructions.
- Read/Write Memory, using R2114 Static RAM devices. Available in 1K byte and 4K byte versions.
- 8K Monitor Program Memory, using R2332 Static ROM devices. Has sockets to accept additional 2332 ROM or 2532 PROM devices, to expand on-board Program memory up to 20K bytes.
- R6532 RAM-Input/Output-Timer (RIOT) combination device. Multipurpose circuit for AIM 65 Monitor functions.
- Two R6522 Versatile Interface Adapter (VIA) devices, which support AIM 65 and user functions. Each VIA has two parallel and one serial 8-bit, bidirectional I/O ports, two 2-bit peripheral handshake control lines and two fully-programmable 16-bit interval timer/event counters.

BUILT-IN EXPANSION CAPABILITY
- 44-Pin Application Connector for peripheral add-ons
- 44-Pin Expansion Connector has full system bus
- Both connectors are KIM-1 compatible

TTY AND AUDIO CASSETTE INTERFACES
Standard interface to low-cost peripherals . . .
- 20 ma. current loop TTY interface
- Interface for two audio cassette recorders
- Two audio cassette formats: ASCII KIM-1 compatible and binary, blocked file assembler compatible

ROM RESIDENT ADVANCED INTERACTIVE MONITOR
Advanced features found only on larger systems . . .
- Monitor-generated prompts
- Single keystroke commands
- Address independent data entry
- Debug aids
- Error messages
- Option and user interface linkage

ADVANCED INTERACTIVE MONITOR COMMANDS
- Major Function Entry
- Instruction Entry and Disassembly
- Display/Alter Registers and Memory
- Manipulate Breakpoints
- Control Instruction/Trace
- Control Peripheral Devices
- Call User-Defined Functions
- Comprehensive Text Editor

LOW COST PLUG-IN ROM OPTIONS
- 4K Assembler—symbolic, two-pass , **A65-010 $79.00**
- 8K BASIC Interpreter **A65-020 $99.00**

POWER SUPPLY SPECIFICATIONS
- +5 VDC ± 5% regulated @ 2.0 amps (max)
- +24 VDC ± 15% unregulated @ 2.5 amps (peak) 0.5 amps average

PRICE: $369.00 (1K RAM) $419.00 (4K RAM)

Plus $4.00 UPS (shipped in U.S. must give ***street*** address), $10 parcel post to APO's, FPO's, Alaska, Hawaii, Canada, $25 air mail to all other countries
AIM 65 USER MANUAL $5.00 plus $1.50 shipping & handling.
We manufacture a complete line of high quality expansion boards. Use reader service card to be added to our mailing list, or U.S. residents send $1.00 (International send $3.00 U.S.) for airmail delivery of our complete catalog.

RNB ENTERPRISES INCORPORATED R20

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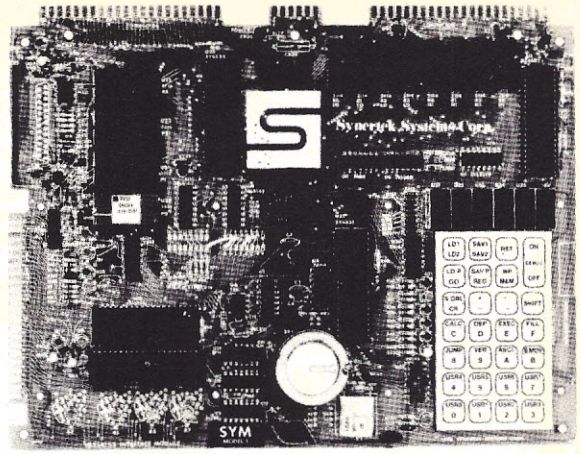
SYM-1, 6502-BASED MICROCOMPUTER



- FULLY-ASSEMBLED AND COMPLETELY INTEGRATED SYSTEM that's ready-to-use
- ALL LSI IC'S ARE IN SOCKETS
- 28 DOUBLE-FUNCTION KEYPAD INCLUDING UP TO 24 "SPECIAL" FUNCTIONS
- EASY-TO-VIEW 6-DIGIT HEX LED DISPLAY
- KIM-1* HARDWARE COMPATIBILITY
  The powerful 6502 8-Bit MICROPROCESSOR whose advanced architectural features have made it one of the largest selling "micros" on the market today.
- THREE ON-BOARD PROGRAMMABLE INTERVAL TIMERS available to the user, expandable to five on-board.
- 4K BYTE ROM RESIDENT MONITOR and Operating Programs.
- Single 5 Volt power supply is all that is required.
- 1K BYTES OF 2114 STATIC RAM onboard with sockets provided for immediate expansion to 4K bytes onboard, with total memory expansion to 65, 536 bytes.
- USER PROM/ROM: The system is equipped with 3 PROM/ROM expansion sockets for 2316/2332 ROMs or 2716 EPROMs
- ENHANCED SOFTWARE with simplified user interface
- STANDARD INTERFACES INCLUDE:
  - —Audio Cassette Recorder Interface with Remote Control (Two modes: 135 Baud KIM-1* compatible, Hi-Speed 1500 Baud)
  - —Full duplex 20mA Teletype Interface
  - —System Expansion Bus Interface
  - —TV Controller Board Interface
  - —CRT Compatible Interface (RS-232)
- APPLICATION PORT: 15 Bi-directional TTL Lines for user applications with expansion capability for added lines
- EXPANSION PORT FOR ADD-ON MODULES (51 I/O Lines included in the basic system)
- SEPARATE POWER SUPPLY connector for easy disconnect of the d-c power
- AUDIBLE RESPONSE KEYPAD

Synertek has enhanced KIM-1* software as well as the hardware. The software has simplified the user interface. The basic SYM-1 system is programmed in machine language. Monitor status is easily accessible, and the monitor gives the keypad user the same full functional capability of the TTY user. The SYM-1 has everything the KIM-1* has to offer, plus so much more that we cannot begin to tell you here. So, if you want to know more, the SYM-1 User Manual is available, separately

SYM-1 Complete w/manuals	**$229.00**
SYM-1 User Manual Only	**$7.00**
SYM-1 Expansion	**$60.00**

Expansion includes 3K of 2114 RAM chips and 1-6522 I/O chip.

SYM-1 Manuals: The well organized documentation package is complete and easy-to-understand.

SYM-1 CAN GROW AS YOU GROW. It's the system to BUILD-ON. Expansion features that are available:

BAS-1 8K Basic ROM (Microsoft Basic)	**$89.00**
KTM-2 (Complete terminal less monitor)	**$319.00**

QUALITY EXPANSION BOARDS DESIGNED SPECIFICALLY FOR KIM-1, SYM-1 & AIM 65

These boards are set up for use with a regulated power supply such as the one below, but, provisions have been made so that you can add onboard regulators for use with an unregulated power supply. But, because of unreliability, we do not recommend the use of onboard regulators. All I.C.'s are socketed for ease of maintenance. *All boards carry full 90-day warranty.*

All products that we manufacture are designed to meet or exceed industrial standards. All components are first qualtiy and meet full manufacturer's specifications. All this and an extended burn-in is done to reduce the normal percentage of field failures by up to 75%. To you, this means the chance of inconvenience and lost time due to a failure is very rare; but, if it should happen, we guarantee a turn-around time of less than forty-eight hours for repair.

Our money back guarantee: If, for any reason you wish to return any board that you have purchased directly from us within ten (10) days after receipt, complete, in original condition, and in original shipping carton; we will give you a complete credit or refund less a $10.00 restocking charge per board.

VAK-1 8-SLOT MOTHERBOARD

This motherboard uses the KIM-4* bus structure. It provides eight (8) expansion board sockets with rigid card cage. Separate jacks for audio cassette, TTY and power supply are provided. Fully buffered bus.

VAK-1 Motherboard — $129.00

VAK-2/4 16K STATIC RAM BOARD

This board using 2114 RAMs is configured in two (2) separately addressable 8K blocks with individual write-protect switches.

VAK-2 16K RAM Board with only 8K of RAM (½ populated)	**$239.00**
VAK-3 Complete set of chips to expand above board to 16K	**$125.00**
VAK-4 Fully populated 16K RAM	**$325.00**

VAK-5 2708 EPROM PROGRAMMER

This board requires a +5 VDC and ±12 VDC, but has a DC to DC multiplyer so there is no need for an additional power supply. All software is resident in on-board ROM, and has a zero-insertion socket.

VAK-5 2708 EPROM Programmer — $249.00

VAK-6 EPROM BOARD

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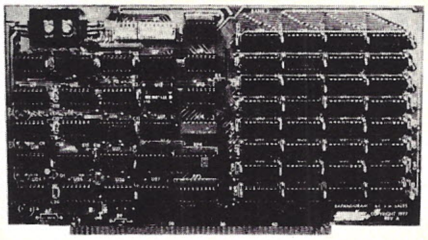

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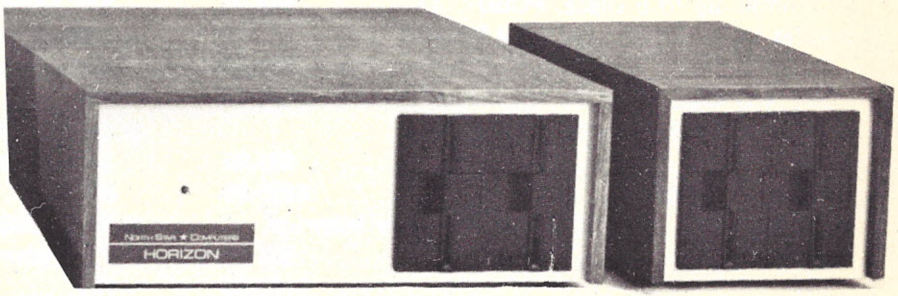

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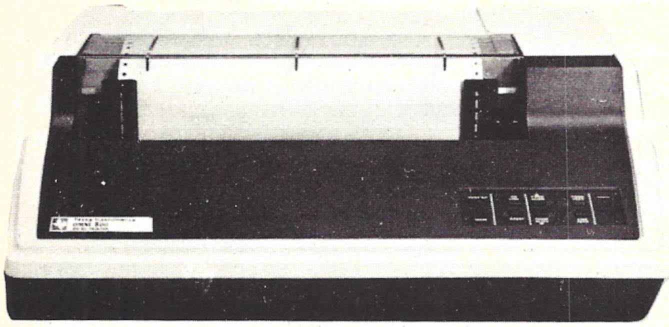

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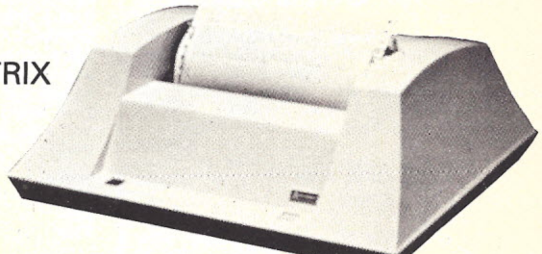

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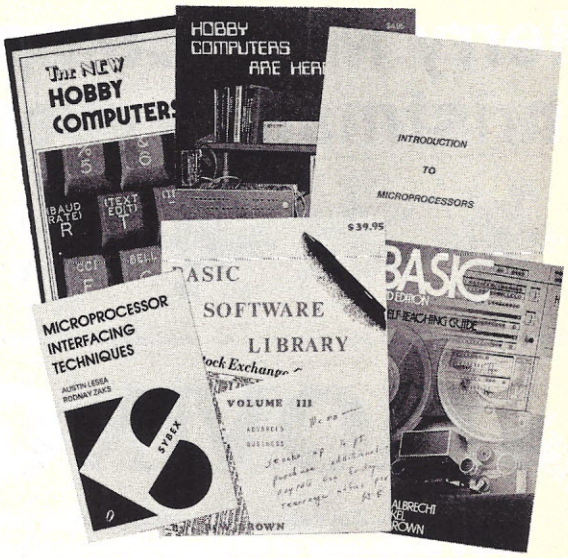

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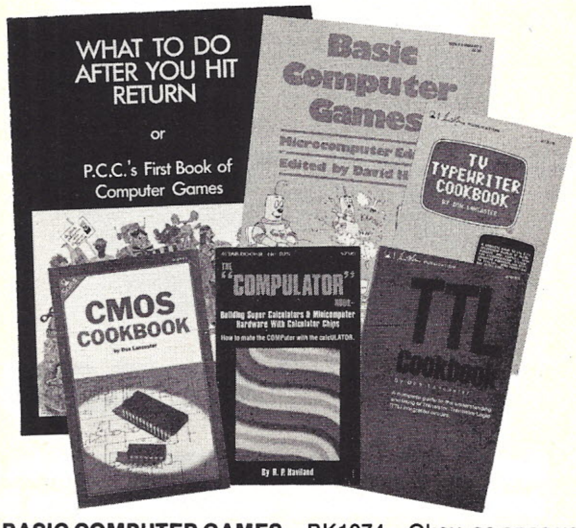

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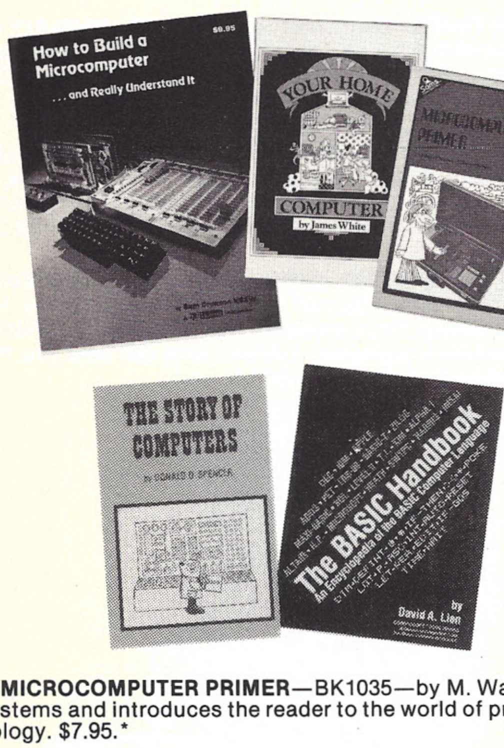

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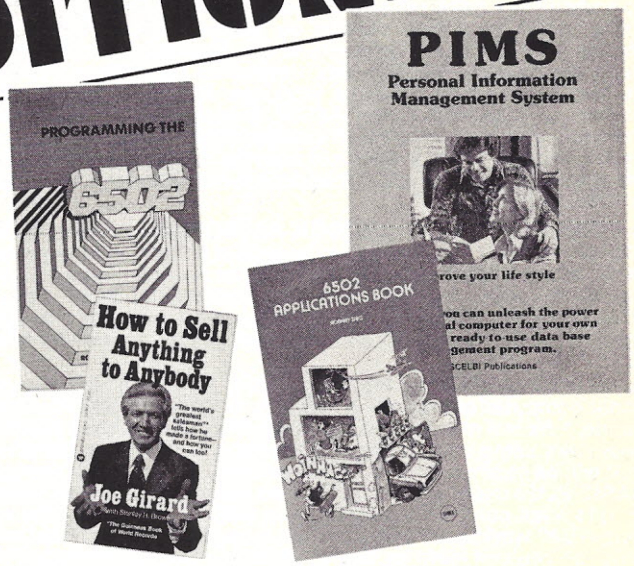

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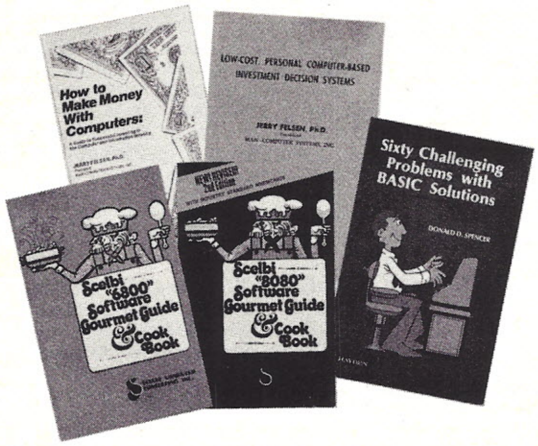

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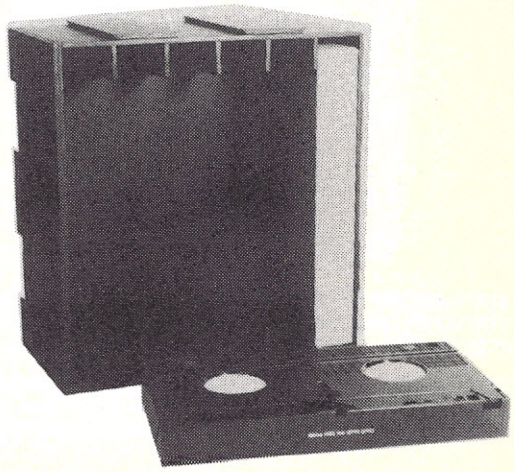

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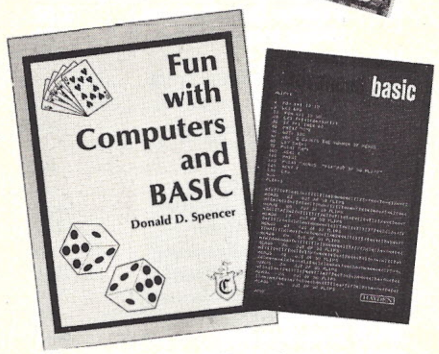

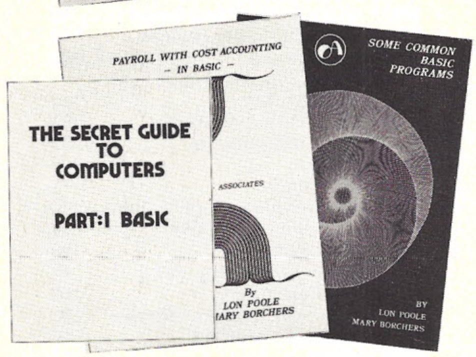

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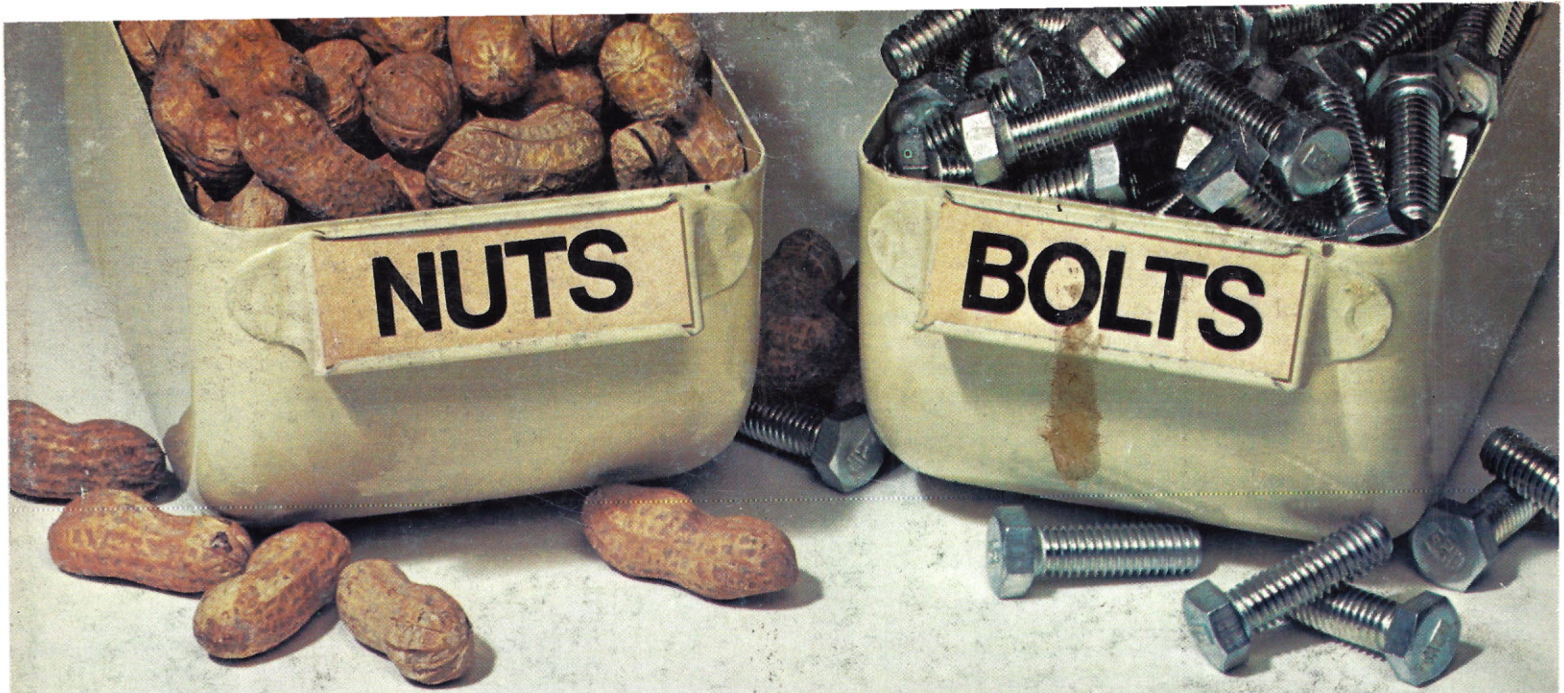

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